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CONTENTS

ARTICLES

RESPONSE TO FERTILIZER AND MICRO-NUTRIENTS IN THE NURSERY OF SOME FOREST SPECIES.
A.K. Chinnathurai, R. Vivekanandan and G. Kumaravelu 273

SOIL MANAGEMENT, A NEW HOPE FOR LATERITIC FORESTS OF WEST BENGAL.
Aparajita Nandi and S. Barari 280

EFFECT OF LOPPING INTENSITIES ON WATER POTENTIAL, REGROWTH, 14 C-PHOTOSYNTHATE DISTRIBUTION AND BIOMASS PRODUCTION IN *ALNUS GLUTINOSA*.
K.A. Singh and F.B. Thompson 285

PHYSICAL AND MECHANICAL PROPERTIES OF *EUCALYPTUS GRANDIS* AND *E. TERETICORNIS* GROWN IN KERALA.
K.M. Bhat and P.K. Thulasidas 297

GENETIC ENHANCEMENT AND MASS PRODUCTION OF QUALITY PROPAGULES OF *BAMBUSA NUTANS* AND *DENDROCALAMUS MEMBRANACEOUS*.
R. Yasodha, R. Sumathi, P. Malliga and K. Gurumurthi 303

BIOCONTROL OF DAMPING OFF OF *EUCALYPTUS TERETICORNIS* SM. USING ECTOMYCORRHIZAE.
M. Narayana Bhat, R. Jeyarajan and B. Ramaraj 307

EFFICIENT PLANT REGENERATION FROM SEEDS AND NODAL SEGMENTS OF *DENDROCALAMUS STRICTUS* USING *IN-VITRO* TECHNIQUE.
Subrata Maity and Anjan Ghosh 313

SUSCEPTIBILITY LEVEL OF FEW PLANTS ON BASIS OF AIR POLLUTION TOLERANCE INDEX.
S. Agrawal and S.L. Tiwari 319

ENDOMYCORRHIZAL ASSOCIATIONS OF ACACIAS IN NURSERIES AND PLANTATIONS OF INDIAN ARID ZONE.
V. Mohan and Y.P. Singh 323

FRONT COVER

NATURAL MIXED FOREST, POTHIBASA, DISTRICT CHAMOLI (U.P.).

Photo - S. Nautiyal

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PHENOTYPIC STABILITY OF *AGAVE* SPECIES ON BOULDERY WASTELANDS (RIVERBED) OF DOON VALLEY.
R.K. Gupta, M.C. Agarwal and P. Joshie 331

GERMINATION STUDIES ON A FEW MULTIPURPOSE NITROGEN FIXING TREE SPECIES USED IN AFFORESTATION PROGRAMMES IN CENTRAL HIMALAYA.
Urmila Rana and K.S. Rao 338

RESEARCH NOTES

I. BLISTER BEETLES AS A THREAT TO MEDICINAL/ ORNAMENTAL PLANTS OF ARID AND SEMI-ARID REGIONS.
S. Murugesan, Shivesh Kumar and R. Sundararaj 341

II. PRELIMINARY STUDIES ON THE GERMINATION BEHAVIOUR OF SOME SHRUB SPECIES OF HIMALAYAS.
V.K. Bahuguna and Pyare Lal 345

LETTERS TO THE EDITOR

I. "Root Trainer" - A.K. Saxena 348
II. "Autonomy in the Forestry Training" - Abhijit Ghose .. 353
III. "Gregarious flowering of *Bambusa nutans* in Nepal Himalaya" - Sas. Biswas 355

REVIEWS 356

FELICITATION 356

OBITUARY 357

GAZETTE NOTIFICATIONS 357

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RESPONSE TO FERTILIZER AND MICRO-NUTRIENTS IN THE NURSERY OF SOME FOREST SPECIES

A.K. CHINNATHURAI*, R. VIVEKANANDAN** AND G. KUMARAVELU***

Introduction

Leguminous tree species are preferred to afforest wastelands as they efficiently fix nitrogen. Hence species like *Acacia nilotica, Acacia leucophloea, Acacia planifrons, Albizia lebbek* and *Pongamia pinnata* are planted in degraded areas. These are major species in many of forest nurseries in Tamil Nadu. In the nurseries the seedlings are kept for four to six months period to attain plantable height. To shorten the nursery period of these species trials were initiated to find out the response to fertilizer and micro-nutrient applications at Coimbatore during May and June 1989.

Review of Literature

Agarwal and Bhatnagar (1983) has arrived at the optimum dose of fertilizer for *Pinus caribea* seedling as 200 mg of Nitrogen and Phosphorus and 300 mg of Potassium. It is inferred that the sub (100 mg) and supra dose (300 mg) of Nitrogen reduced the height and diameter. The total fresh weight is not affected, but the dry weight increased with increasing nitrogen. Sundararaju and Chinnathurai (1990, 1991) arrived at the optimum dose for *Eucalyptus globulus* and *Eucalyptus tereticornis* as 0.4 gm urea, 1 gm superphosphate and 0.3 gm potash in bags of 13 x 25 cm. In the case of *Eucalyptus camaldulensis* the optimum dose is 0.6 gm urea, 1.5 gm superphosphate and 0.45 gm potash. Micro-nutrient has no significant effect on the growth of *Eucalyptus tereticornis* and *Eucalyptus camaldulensis*.

Materials and Methods

The nursery experiment was carried out in polythene bags of size 13 x 25 cm, using red soil. The soil was tested and the soil test values are furnished below :

(1) Electrical conductivity - 0.05 m.mho/cm
(2) pH - 2.1 water and soil - 8.0
(3) Available N - 346 kg/ha, P - 6.4 kg/ha, K - 27 kg/ha
(4) Available Zinc - 4.81 ppm, Iron - 23.5 ppm, Manganese - 3.75 ppm and copper - 1.15 ppm

The soil was filled upto 3/4th of the bags and fertilizer was applied and the bags were again filled up with the soil.

The experiment was laid out in May-June 1989 in strip plot design with six fertilizer levels as 'A' major plots and three micro-nutrient levels as 'B' major plots in the replications. The following were the treatments tried (Table 1).

Superphosphate was applied basally before pricking out. Urea and potash required for 500 plants were weighed separately and dissolved in 5 liters of water

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Table 1

(A) Major plots (Quantity g per seedling)

Fertilizer treatment	Urea (gm)	Super-phosphate (gm)	Muriate of Potash (gm)
A1 Control (No fertilizer)			
A2	0.1	0.5	0.15
A3	0.2	0.5	0.15
A4	0.4	1.0	0.30
A5	0.6	1.5	0.45
A6	0.8	2.0	0.60

(B) Major plots (Quantity mg per seedling)

Micro-nutrients	Treatment		
	B1	B2	B3
Borax	0	0.5	1.0
Sodium molybdate	0	0.5	1.0
Copper sulphate	0	2.5	5.0
Manganese sulphate	0	2.5	5.0
Ferrous sulphate	0	5.0	10.0
Zinc sulphate	0	5.0	10.0
Total	0	16.0	32.0

and 10.0 ml of solutions were measured and applied for each container seedling. One month after pricking out, the micro-nutrients required for 500 plants for each treatment were weighed separately and treated similarly.

In the case of *Pongamia pinnata*, the pods were broken carefully without damaging the kernel and the kernels were dibbled on 3rd May 89 in the polythene bags at 2-3 cm depth. Each sub-plot contained 25 seedlings. Mother beds were raised for *Acacia nilotica, Acacia leucophloea, Acacia planifrons* and *Albizia lebbek* in June 89 and the seedlings were pricked out on 10th day. There were 25 seedlings in each sub-plot of *Albizia lebbek* and *Acacia nilotica*. The plants were limited to 15 in each sub-plot for *Acacia leucophloea* and *Acacia planifrons* for want of space. The heights were recorded. After recording the final height measurement, three representative seedlings were carefully freed from the soil, washed and dried and the dry weights were recorded.

Results and Discussions

(1) ***Acacia nilotica*** : The average heights record for the fertilizer and micro-nutrient treatment are furnished in the Table 2.

The biomass productions recorded for fertilizer and micro-nutrient treatments are furnished in Table 3.

There is significant difference for fertilizer treatments and Control vs rest of micro-nutrient treatments. The optimum dose of fertilizer is A3 B2 as A3 is on par with A4, A5 and A6.

Table 2

Average heights recorded for fertilizer and micro-nutrient treatments - Acacia nilotica

Age in days	Treatments (cm)										
	A1	A2	A3	A4	A5	A6	CD	B1	B2	B3	CD
35	9.4	9.5	10.6	9.5	9.4	10.9	-	9.6	9.8	10.2	-
70	21.8	22.3	23.3	23.7	23.5	25.9	-	22.9	23.2	23.2	-
106	27.1	29.5	29.2	31.2	80.9	33.7	3.1	29.7	30.4	30.3	0.75
141	33.0	35.2	34.4	37.7	37.2	40.6	4.5	35.7	36.6	36.6	-

Table 3

Biomass production (gm) : Acacia nilotica

Micro nutrient	Fertilizer level							
	A1	A2	A3	A4	A5	A6	Mean	
B1	17.0	14.7	16.7	18.0	20.0	18.9	17.5	CD = 1.3 gm
B2	16.0	16.7	19.3	19.3	20.0	19.9	18.5	For control
B3	15.7	19.0	20.6	20.7	19.0	20.0	19.3	(17.5 gm)
Mean	16.2	17.0	18.9	19.3	19.7	19.4	18.4	vs rest of micro-
CD	2.3	(For fertilizer treatments)						nutrients (18.9 gm)

In case, the nursery is stunted in growth and it is meant for degraded area the dose may be increased to A4 B3.

(2) ***Acacia leucophloea*** : The average heights recorded for the fertilizer and micro-nutrients are furnished in the Table 4.

The biomass productions for *Acacia leucophloea* are furnished in the Table 5.

The difference in biomass production is not significant for both fertilizer and micro-nutrient treatments. It seems in the initial stage fertilizer could be applied to the extent of A2 for boosting the growth as this treatment recorded the maximum growth and biomass.

(3) ***Acacia planifrons*** : The average height measurements recorded for *Acacia planifrons* are furnished in the Table 6.

The biomass productions for *Acacia planifrons* are furnished in the Table 7.

The biomass production is significant for the fertilizer treatments only. A5 and A6 are recording significantly more biomass than Control.

(4) ***Albizia lebbek*** : The average height measurements recorded for *Albizia lebbek* are furnished in Table 8.

The biomass productions recorded are furnished in the Table 9.

As regards biomass production the difference is significant only for micro-nutrients.

In *Albizia lebbek* nursery it is better to apply micro-nutrients at B3 level. If the nursery is stunted in growth fertilizer applications may be limited to A2 level with micro-nutrients at B3 level.

(5) ***Pongamia pinnata*** : The growth measurements recorded for *Pongamia pinnata* are furnished in the Table 10.

Statistical analysis of the height measurements indicates that only in the final measurement the growth difference is significant for fertilizer application. The optimum dose is A4.

Conclusion

The cost benefit for application of optimum doses are furnished in Table 11. The number of days required for the dose to attain the height of the treatment under control was arrived graphically. *Acacia nilotica* attains a growth of 33 cm in 141

Table 4

Average heights recorded for fertilizer and micro-nutrients - Acacia leucophloea

Age in days	Treatments (cm)										
	A1	A2	A3	A4	A5	A6	CD	B1	B2	B3	CD
44	4.2	4.3	3.4	5.8	5.6	4.9	1.9	4.5	5.4	4.2	-
75	7.6	8.8	7.0	9.3	9.1	9.2	1.7	8.7	8.8	8.0	0.5
111	13.4	16.5	14.4	15.2	14.3	14.7	-	15.4	14.4	14.4	-

Table 5

Biomass production (gm) : Acacia leucophloea

Micro-nutrient	Fertilizer level						
	A1	A2	A3	A4	A5	A6	Mean
B1	12.3	18.0	13.2	9.0	11.7	12.0	12.7
B2	7.7	15.7	13.0	12.7	8.0	9.7	11.1
B3	7.0	9.3	10.8	14.0	10.0	8.0	9.9
Mean	9.0	14.3	12.3	11.9	9.9	9.9	11.2

Table 6

Average height measurements recorded for Acacia planifrons

Age in days	Treatments (cm)										
	A1	A2	A3	A4	A5	A6	CD	B1	B2	B3	CD
65	6.5	7.3	6.1	6.4	9.9	9.6	0.76	7.4	7.6	7.9	-
67	14.3	14.9	13.1	14.0	18.3	18.2	3.05	15.3	15.7	15.4	-
142	23.5	25.3	24.4	25.7	28.3	30.0	3.63	26.8	26.2	25.6	-

days under Control (A1). This growth could be achieved in 130 days for A3 and in 121 days for A4 treatments. Taking into consideration of maintenance cost for 1000 seedlings, the extra amount for A3 B3 is Rs. 7/- but in case of A4 B3 there is no extra expenditure. The vigour and health of the plant could be decided by the biomass. As A4 is producing more biomass than A3, it is desirable to adopt A4 B3.

If the growth is not satisfactory for *Acacia leucophloea* the fertilizer application may be restricted to A2. This dose will reduce the nursery period by 13 days to attain a growth of 13.4 cm (recorded for Control in 111 days) and maintenance cost by Rs. 5.50/-.

The optimum dose for *Acacia planifrons* as discussed above is A5. This dose will attain a height of 23.5 cm in 126 days reducing the nursery period by 16 days and maintenance cost by Rs. 0.55/- per 1000 seedlings compared to Control which takes 142 days for 23.5 cm growth.

In *Albizia lebbek* micro-nutrient at B3 level produces more biomass. The recommended optimum dose is A2 B3 as A2

Table 7

Biomass production (gm) : Acacia planifrons

Micro-nutrient	Fertilizer level						
	A1	A2	A3	A4	A5	A6	Mean
B1	10.3	11.7	9.3	9.7	12.0	16.2	11.6
B2	8.7	9.3	12.3	12.3	14.7	17.0	12.4
B3	10.3	10.7	12.7	13.3	10.3	12.0	11.5
Mean	9.7	10.6	11.4	11.8	12.3	15.1	11.8

CD = 2.27 (5% level) 3.23 (1% level) for fertilizer treatment

Table 8

Average height measurements recorded for Albizia lebbek

Age in days	Treatments (cm)										
	A1	A2	A3	A4	A5	A6	CD	B1	B2	B3	CD
43	4.2	3.8	3.9	4.3	4.2	4.6	0.5	4.0	4.2	4.2	-
82	6.8	6.2	6.4	6.5	6.4	6.6	-	6.7	6.0	6.8	-
137	13.3	13.1	13.2	14.4	15.0	15.9	0.8	14.7	13.0	14.8	-

Table 9

Biomass production : Albizia lebbek

Micro-nutrient	Fertilizer level						
	A1	A2	A3	A4	A5	A6	Mean
B1	19.0	22.0	19.3	21.3	20.7	26.3	21.4
B2	18.3	21.3	16.7	20.7	21.3	18.7	19.5
B3	20.3	25.0	22.7	24.7	27.0	24.7	24.1
Mean	19.2	22.9	19.6	22.2	23.0	23.2	21.7

CD = 2.33 (5% level), 3.87 (1% level) for micro-nutrient treatments

is recording increased biomass over Control. It would cost Rs. 8.00 extra over and above the maintenance charges for Control.

In Control, *Pongamia pinnata* attains an average height of 20.5 cm in 169 days. The optimum dose of A4 B1 treatment would reduce the nursery period by 47 days and maintenance cost by Rs. 18/- per 1000 seedlings.

Application of fertilizer and micro-nutrient will not only shorten the nursery period but also reduce the cost of maintenance. Incorporation of these NPK and micro nutrients will also favour the establishment in problem soils. Hence the field staff are requested to apply the optimum doses suggested and communicate the findings to the fellow staff for adoption through their transfer of technology wing.

Table 10

Growth measurements recorded for Pongamia pinnata

Age in days	Treatments (cm)										
	A1	A2	A3	A4	A5	A6	CD	B1	B2	B3	CD
61	13.1	13.8	13.4	15.0	13.5	14.5	-	13.4	14.3	13.9	-
91	15.4	16.3	16.6	18.0	16.3	18.1	-	15.9	17.2	17.0	-
134	18.8	19.6	19.5	21.9	19.3	21.0	-	19.3	20.6	20.2	-
169	20.5	21.9	21.6	24.1	22.3	24.6	2.6	21.9	23.2	22.5	-

Table 11

Maintenance charge per 1000 seedlings

Species	Treatment	Days	Watering	Shifting charges	Cost of fertilizer application	Maintenance cost	Cost difference over and above Control
Acacia nilotica for 33 cm growth							
	control	141	52.25	46.25	-	98.50	-
	A3 - B3	130	50.60	46.25	8.50	105.35	6.85
	A4 - B3	121	49.50	37.00	11.50	98.00	(-) 0.50
Acacia leucophloea for 13.4 cm growth							
	Control	111	47.85	37.00	-	84.85	-
	A2 - B1	98	44.55	27.75	7.00	79.30	(-)5.55
Acacia planifrons for 23.5 cm growth							
	Control	142	52.25	46.25	-	98.50	-
	A5 - B1	126	48.95	37.00	12.00	97.95	(-) 0.55
Albizia lebbek for 13.3 cm growth							
	Control	137	54.45	46.25	-	100.70	-
	A4- B3	130	53.35	46.25	11.50	111.10	10.40
Pongamia pinnata for 20.5 cm growth							
	Control	169	62.15	55.50	-	117.65	-
	A4 - B1	122	52.25	37.00	10.50	99.75	(-) 17.90

SUMMARY

There is significant response for fertilizer and micro-application for *Acacia nilotica* in growth increase and biomass production in the nursery. In *Acacia leucophloea* initially there is response for fertilizer, but later on the response was not significant. The response to fertilizer application is felt only during later stage for *Pongamia pinnata*. *Acacia planifrons* responds to fertilizer application for growth and biomass production. The optimum dose is 0.6 gm Urea, 1.5 gm Superphosphate and 0.45 gm muriate of potash. Micro nutrients requirements for *Acacia nilotica* and *Albizia lebbek* are 1 mg in each of Borax and Sodium Molybdate, 5 mg in each of Copper sulphate and Manganese sulphate and 10 mg in each of Zinc sulphate and Ferrous sulphate.

कतिपय वन वृक्ष जातियों पर रोपणी में उर्वरकों और सूक्ष्म पोष्याहारों का प्रतिचार

ए०के० चिन्नादुरई, आरविवेकानन्द व जी० कुमारवेलु

सारांश

रोपणी में उगाए *अकेसिया नीलोटिका* की बढ़वार तथा जैवपुंज उत्पादन में उर्वरक और सूक्ष्म पोष्याहार दिए जाने पर काफी प्रतिचार होता है । *अकेसिया ल्युकोफिलआ* में आरम्भ में उर्वरको का प्रतिचार होता है परन्तु बाद में चलकर यह प्रतिचार काफी नहीं रह जाता । *पोंगामिया पिन्नाटा* में उर्वरक देने को प्रतिचार केवल बाद की अवस्था में होता पाया गया । *अकेसिया प्लेनिफ्रोंस* की बढ़वार और जैवपुजं उत्पादन देने पर भी उर्वरक देने का प्रतिचार होता है । देने की पष्टतम मात्रा 0.6 ग्राम यूरिया, 1.5 ग्राम सुपरफास्फेट और 0.45 ग्राम पोटाश म्यूरेट है । *अकेसिया नीलोटिका* और *एल्बीजिया लेब्बेक* के लिए सूक्ष्म पोष्याहारों की आवश्यकता सुहागा और सोडियम मोलिबडेट प्रत्येक एक मिली ग्राम, कोपर सल्फेट और मैंगनीज सल्फेट प्रत्येक 5 मिलिग्राम और जस्ता सल्फेट और लोहा सल्फेट प्रत्येक 10 मिलिग्राम होती है ।

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SOIL MANAGEMENT, A NEW HOPE FOR LATERITIC FORESTS OF WEST BENGAL

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Introduction

In the Lateritic soils in general, leaching of bases is a common phenomenon. So, Lateritic soils are acidic which drop down to less then 5 in many areas, mostly in barren lands and even under some vegetation of lateritic region. For the purpose of characterization and classification acid soils have been defined by USDA as having pH less than 5.5 in 1 : 1 soil water suspension. The soil of lateritic forests due to its acidic nature contains high amount of exchangeable H^+ and Al^{+3}. These soils have also low CEC.

The presence of Al^{+3}, Mn^{+2} and Fe^{+2} in higher concentration and deficiency of Ca^{+2}, Mg^{+2} and P, causes inhibition of root growth and microbial imbalance. The nutrient availability is closely related to soil pH (Prasad, 1992).

Soil acidity also inhibits N_2 fixation and the population of Bacteria and Actinomycetes are lower and Fungi population are higher.

Previous studies in acid soils by ameliorating the soils through the application of amendment to counteract soil acidity have been done mostly on agricultural crops by liming. Kotur and Rao (1976) compared different methods of study and lime requirements to obtain optimum growth of paddy in pot experiments. The results had shown positive response and favourable nutrient response. Yield depression was also obtained due to over liming. Of course, optimum lime requirement has to be determined for a particular soil so as to have maximum productivity. The direct and residual beneficial effects of lime were also reported by many workers (Mandal, 1976; Prasad *et al.*, 1983, 1985).

As it is well known fact that in general liming affects solubility and availability of most of the plant nutrients raises the level of exchangeable base status, influences the nutrient uptake of plants, improves soil structure and promotes root distribution in acid soils; the process can be tried effectively and successfully on forest plantation of lateritic soils of West Bengal.

Studying the highly weathered soils of humid tropical forests of Brazil, Columbia and Puerto-Rico, Amedee and Peech (1976), found that after liming Ca^{+2} retention within the soil occurs even upon successive extraction with considerable amount of water is done. Indication of fixation of Ca^{+2} in non-exchangeable form is also not found. This ensures the effect of liming to linger for a considerable period.

Fertilizer application greatly reduces soil pH (Yuan *et al.*, 1976). In forest soils, fertilizer application is now-a-days a common practice. So liming can reclaim the forest soils as well. Though the soil pH of lateritic soils of West Bengal is below 5 in some cases the suggested range value of *Eucalyptus tereticornis* has been found to be 5.3 to 6.3 (Banerjee *et al.*, 1986) in this region. The suggested range value for coppice Sal has been found to be 5.5 to 6.5 (Banerjee *et al.*, 1989). This shows that correction of soil pH by its amendment through liming is a requirement to increase productivity in this region.

A Glasshouse study on *Shorea robusta* and *Eucalyptus tereticornis* on the effect of liming on the growth and fertilizer was carried out. The comparative study includes the productivity in original soil (pH 4.8) and lime amended soil (at pH 6.5). Preliminary results show a better yield and fertilizer use efficiency can be ensured by pH amendments with lime.

Materials and Methods

The soils of the experiment were collected as required from the barren land near plantation site at Midnapore. First of all the pH of the collected soil was tested by the pH meter which was 4.8 (1: 2.5). The acidity correction was done after estimating the requirement of lime from lime requirement curve, which was prepared as per standard procedure. The lime (CaO) was mixed up well with soil 3 weeks in advance and left with occasional moisturing. After 3 weeks, the polypots were filled up with soil both original and corrected (i.e. pH 6.5) soils at the rate of 2 kg for each polypot. Then 3 gm sufalam were added on treatment Nos. T_2, T_4, T_6 and T_8. Then the seeds were sown in each polypot on 12.6.92 and 100% germination were survived within 12.7.92 in the case of *Shorea robusta*. The pH value of the corrected soils was tested before sowing seeds. Watering was done regularly. D.A.P. fertilizer was applied after taking initial height measurement of the seedling in each polypot i.e. on 1.8.93. Final growth height measurements were taken on 20.1.93.

Treatments (T)

T_1 = Original soil (i.e. Control pH 4.8)
T_2 = Original soil + 3 gm Sufalam/Polypot.
T_3 = Original soil + 1 gm D.A.P./Polypot.
T_4 = Original soil + 3 gm Sufalam + 1 gm D.A.P./Polypot
T_5 = Corrected soil (i.e. pH 6.5)
T_6 = Corrected soil + 3 gm Sufalam/Polypot
T_7 = Corrected soil + 1 gm D.A.P./Polypot
T_8 = Corrected soil + 3 gm Sufalam + 1 gm D.A.P./Polypot.

Experiment was designed in randomised block with three replications and the number of seedlings in each treatment was 6. So, total nos. of seedling for each species was 8 x 3 x 6 = 144 Nos.

Results and Discussion

Since treatment is significant at both 1% and 5% level. So, 'F' is highly significant i.e. effect of the different treatments are not identical.

Now, Standard Error of difference of any two mean

i.e $SE_m = \pm 3.70$
C.D. at 1 % = 11.01
C.D. at 5 % = 7.94
C.V. = 5 %

Over the control T_2, T_3, T_5 and T_6 show negative difference although they are statistically at par. Again, T_4 and T_7 are

Table 1

Growth height increase in cm (Spp. Eucalyptus tereticornis)

Treatments	Mean height	Height Increased/ decreased over Control.
T_1	86.87	-
T_2	79.98	6.89 (-)
T_3	84.30	2.57 (-1)
T_4	93.46	6.59 (+)
T_5	79.30	7.57 (-)
T_6	82.08	4.79 (-)
T_7	90.24	3.27 (+)
T_8	95.37	8.5 (+)
	691.60	

G M = 86.45

Variance analysis table

Source of variation	df.	SS.	Ms.	F-value	Table value F at level.	
					1%	5%
Replication	2	107.13	53.57	2.61	6.51	3.74
Treatments	7	780.08	111.44	5.43**	4.46	2.85
Error	14	287.10	20.51			

positively at par with Control. Hence, significant growth difference was observed in different treatments and highest growth height increased over control was obtained by the application of T_8 at 5% level. Therefore, for getting significant increase of growth height T_8 is appeared to be effective.

From the Table 2, it is observed that over the control treatment two and treatment six show 'negative' difference although they are statistically at par. Again, treatment three, four, five, seven and eight are positively 'at par' with Control.

Hence, significant growth difference was observed in different treatments and highest growth over Control was obtained by the application of treatment seven at 5% level where as treatment eight at both in 1% and 5% level, i.e. highly significant. Therefore, for getting significant increase of growth height, treatment seven and treatment eight are appeared to be effective. In this connection it is necessary to mention here that tip drying of *Shorea robusta* is observed at the time of final measurement i.e. in the month January '93 at 5 months 19 days age which may be a factor of irregular growth variances of *Shorea robusta*.

Conclusion

The highest growth height of *Eucalyptus tereticornis* is measured in treatment eight and of *Shorea robusta* in treatment T_7 as well as treatment T_8 i.e. 1 gm D.A.P. with corrected soil per polypot and 1 gm D.A.P. with 3 gm Sufalam on corrected soil per polypot respectively in this lateritic soil. Thus, the fertilizing use

Table 2

Growth height increase in cm (Spp. Shorea robusta)

Treatments	Mean height	Height increase/ decreased over Control
T_1	6.13	-
T_2	5.56	0.57 (-)
T_3	8.37	2.24 (+)
T_4	8.35	2.22 (+)
T_5	7.10	0.97 (+)
T_6	5.34	0.79 (+)
T_7	10.86	4.73 (+)
T_8	13.98	7.85 (+)
	65.69	

G.M = 8.21

Analysis of variance table

Source of variation	df.	SS.	Ms.	F-value	Table value at level.	
					1%	5%
Replication	2	19.15	9.575	2.44	6.51	3.74
Treatments	7	183.49	26.21	6.69**	4.46	2.85
Errors.	14	54.87	3.92			

Now, SEM = ± 1.62
C.D. at 1% = 4.82
C.D. at 5% = 3.47
CV = 24 %

efficiency may be increased by application of organic manure and correction of soil acidity. However, field trials should be conducted as a follow up action to the result of Glass house trial.

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SUMMARY

Liming is important for the management of lateritic acid soils, for it has considerable influence on growth of plants and soil environment, besides neutralising soil acidity. In acid soil the availability of Ca^{+2}, Mg^{+2} and P decreases, where as that of Al^{+3}, Fe^{+2} and Mn^{+2} increases. Thus the nutrient availability is closely related to soil pH. A Glasshouse experiment was carrried out to find out the

effect of liming with inorganic fertilizer and organic manure on two forest plant types i.e. *Eucalyptus tereticornis* and *Shorea robusta*. As per the preliminary analysis in Glasshouse condition the growth of two plant types was found significant in limed soil with organic manure and inorganic fertilizer. The initial start i.e. both root and shoot development may help for better establishment of forest spp.

पश्चिम बंगाल के इष्टकिजीय वनों के लिए नई आशा किरण - मृदा प्रबन्ध

अपराजिता नन्दि व एस० बरारी

सारांश

इष्टकिजीय (लेटराइटी) अम्ल मृदाओं का प्रबन्ध करने में चूना देना बहुत महत्वपूर्ण है क्योंकि मृदा की अम्लता को कम करने के अतिरिक्त यह पादपों और मृदा की पर्यावरण की बढ़वार पर भी काफी प्रभाव डालता है । अम्ल मृदाओं में कैलशियम,+2 मेगनिशियम +2 और फास्फोरस की उपलभ्यता घटती है और अलुमिनियम, +3 लोहा +2 और मेंगनीज,+2 की उपलभ्यता में वृद्धि होती है । इस तरह पोष्याहारों की उपलभ्यता का मृदा पीएच के साथ निकट का संबन्ध है । दो प्रकार के वन पादपों आर्थात् *युकेलिप्टस टेरेटिकार्निस* और *शोरिया रोबस्टा* में अजैव उर्वरक और जैव खाद देने के साथ मिलाकर चूना देने का प्रभाव ज्ञात करने के लिए एक कांचघर संपरीक्षण किया गया । प्रारम्भिक विश्लेषणों के अनुसार कॉचघर दशाओं में दोनो प्रकार के पादपों मे जैव खाद और अजैव उर्वरकों के साथ चूना डाली गई मृदाओं में बढवार काफी अधिक होती पाई गई । प्रारम्भिक शुरुआत अर्थात् जडें और प्ररोह विकास दोनों वन वृक्ष जातियों के अधिक अच्छी तरह से स्थापित होने में सहायक सिद्ध हो सकती है ।

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EFFECT OF LOPPING INTENSITIES ON WATER POTENTIAL, REGROWTH, 14 C-PHOTOSYNTHATE DISTRIBUTION AND BIOMASS PRODUCTION IN *ALNUS GLUTINOSA*

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Introduction

Lopping is practiced to harvest tree leaves for fodder and green manure or to regulate shade under agroforestry systems. The removal of growing buds and leaf area both in lopping may affect physiological processes differently than the removal of source alone in the case of defoliation. Studies on the effects of lopping on growth and harvestable biomass have been done in some shrubs and trees by Shephered (1971), Kotwal (1981), Sharma and Gupta (1988) and Tsiouvaras *et al*. (1986). However, no information is available on the effects of lopping on various physiological processes in detail.

Physiological response to defoliation can be expressed as the time lag between the period of growth of defoliated and under-foliated plants on resumption of normal growth. Regrowth was related to an increase in net assimilation rate due to improved water status of the plants as well as investment of photosynthates on the growth of aboveground parts (Prins *et al*., 1989). Cessation of exudation of plant sap from cut surfaces and the reduction in transpiring leaf area surfaces improved hydration of defoliated plants (Verkaar, 1988). Studies have postulated that a defoliated plant transports a greater per cent of 14 C-photosynthate to the expanding shoot and lateral branches and less to the roots within 24 hours of defoliation (Bassam and Dickmann, 1985). Further, if the available assimilate are quantitatively limited, the regrowth uses stored carbohydrates (Kulman, 1965; Rook and White, 1976). The degree of defoliation and capacity of the plants to recover have been found negatively correlated (Meidjen *et al*., 1988).

With these background, present study was carried out to know the effects of lopping intensity on water potential, transpiration, regrowth, 14 C-photosynthate distribution and biomass production in the deciduous, non-leguminous N_2 fixing tree, *Alnus glutinosa* (L.) Gaertn.

Materials and Methods

In April 1989, three years old *Alnus glutinosa* (L.) Gaertn plants were transplanted in 18 litre pots. After two months, 72 uniform size of plants were selected and lopping treatments were imposed. Leaves along with the stem portion were clipped off to impose 30, 60 and 90 per cent lopping and equal number of control (unlopped) plants were kept for comparison. The lopping treatments were executed based on number of leaves on each branch of the each plant and the actual leaf area (Y) was computed by a regression equation: $Y = 7.278X - 15.88$ ($r = 0.97$, X - leaf length). The actual leaf area removed under these lopping treatments were 28, 56 and 80 per cent in Experiment I and 30, 60 and 81 per cent in Experiment II. The experiments were conducted in open space.

Experiment I : Studies on water potential, transpiration, water use efficiency and regrowth were done on a set of 40 plants given lopping treatments. Water potential was measured at 12 noon by a pressure bomb (Scholander *et al.*, 1965). Two plants from each treatment were sampled at one stage of observation to avoid removal of many twigs from a single plant. Transpiration rate per plant was determined by gravimetric method. The evaporation of soil moisture was prevented by enclosing the pots in the double layered plastic bags tied loosely to the stem of plants. From each treatment, two plants wer destructively sampled at a stage of observation to determine leaf area, net assimilation rate, relative growth rate and water use efficiency. The data on various parameters were analysed in a randomized block design by taking lopping treatments X stages of observation as the treatment combinations with two replications.

Experiments II : Studies on the pattern of 14 C-photosynthate distribution under different lopping treatments were made on 32 plants. (a) To see immediate effects of lopping treatments, 16 plants were fed 14 CO_2 at 24 hours after lopping treatments. In each treatment, two plants were fed 14 CO_2 through a branch located in the bottom part of the main stem and other two plants from the same treatment were fed 14 CO_2 through a branch located in the top part of the main stem. The selected branch was enclosed in a mylar bag (45 x 33cm) for 14 CO_2 exposure. Inside the bag, on 20 ml uncapped plastic bottle containing 0.6 ml Na14 CO_3 (3.7 x 10 Bq.) was fixed with adhesive tape. The bag was sealed with a closed bedding tape and a plastic sealing clip. 14 CO_2 was liberated by injecting 5 ml 20% lactic acid (v/v) through a syringe into the plastic bottle. The bag was agitated periodically during three hours assimilation period (Rangnekar and Forward, 1973). Remaining 14 CO_2 inside the bag was neutralized by injecting 10 ml KOH (one molar solution). The plants were given 48 hours time for assimilation and distribution of 14 C-photosynthate to different parts of the plants (Bassam and Dickmann, 1985). The treated plants were divided into nine parts i.e. nodules, young fine roots, fine

Table 1

Effect of lopping intensities on water potential (-Mpa) in Alnus glutinosa (L.) Gaertn.

Lopping intensities (Actual leaf area removed)	24 hours	Days after lopping				
		8	28	48	68	88
Control(0)	-1.168	-1.344	-1.249	-1.256	-0.642	0.507
30(28) %	-0.994	-1.195	-1.128	-1.141	-0.554	0.399
60(56) %	-0.939	-0.898	-1.000	-1.081	0.736	0.459
90(80) %	-0.885	-0.729	-0.878	-0.979	-0.635	0.439
LSD (P=0.05)	0.1126					

LSD - Least significant difference, 24h - 24 hours.

Table 2

Effect of lopping intensities on transpiration rate per. tree

Lopping intensities (Actual leaf area removed)	Transpiration rate (g water/tree/day) Days after lopping										
	24 hours	8	16	24	32	40	48	56	64	72	88
Control (0)	732	473	775	542	570	817	733	221	952	713	289
30(28) %	562	272	622	379	466	694	616	226	928	705	416
60(56) %	309	224	451	173	401	534	593	216	837	607	474
90(80) %	150	94	395	98	327	400	538	179	632	453	337
LSD (P = 0.05) 108.9											

LSD - Least significant difference

Table 3

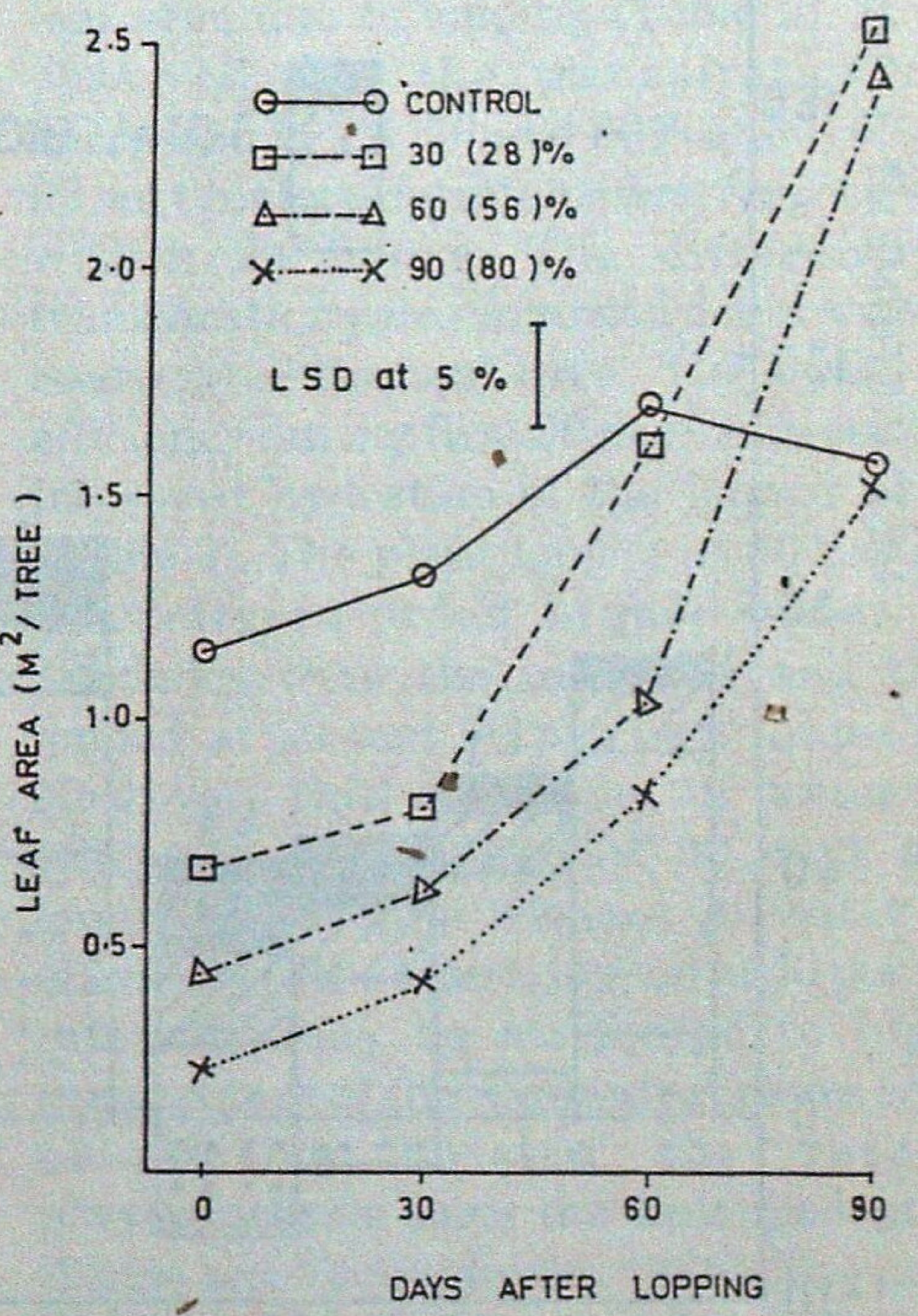
Effect of lopping intensities on water use efficiency

Lopping intensities (Actual leaf area removed)	Water use efficiency (g water/g dry matter)		
	0-30	30-60	60-90
Control.	236	177	70
30(28) %	215	142	70
60(56) %	184	271	60
90(80) %	81	269	89
LSD (P = 0.05)	69.2		

LSD - Least significant difference.

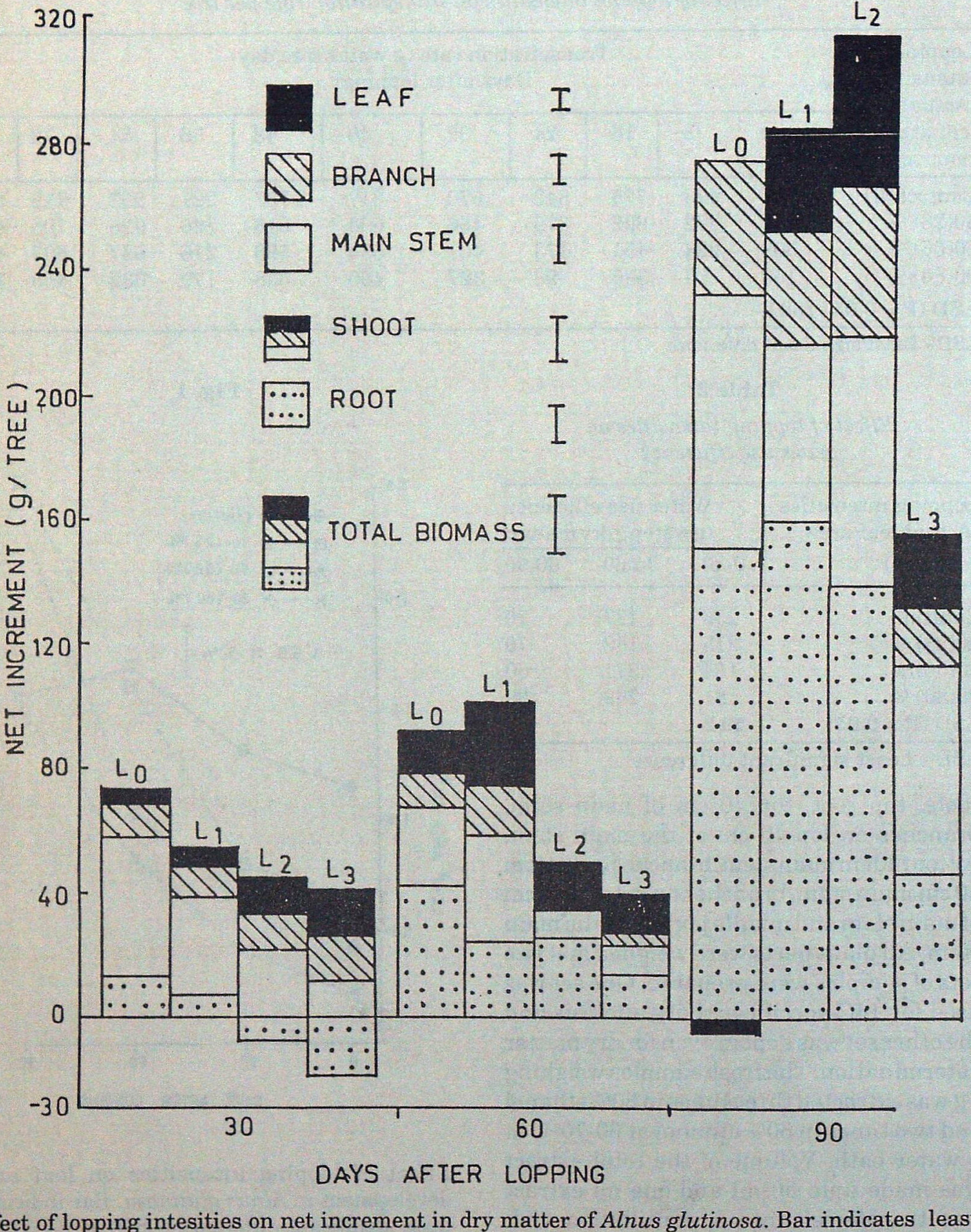
roots, tap root, top 40 cm of main stem, branches on lop 40 cm of the main stem, bottom 40 cm main stem, branches on bottom 40 cm main stem, branches on bottom 40 cm of main stem and middle portion of the main stem. All plant parts were weighed and two sets of samples were prepared. One set was used for 14C-specific activity analysis and the other set was kept in oven for dry matter determination. The fresh samples weighing 3 g was extracted three times in 80% ethanol and two times in 60% ethanol at 60-70° C in a water bath. Volume of the total extract was made upto 50 ml and one ml extract was transferred into a scintillation vial. Four ml BDH Sentren Cocktail T was added to the samples. Counting of 14 C-specific

Fig. 1



Effect of lopping intensities on leaf area development in *Alnus glutinosa*. Bar indicates least significant difference (LSD) at P - 0.05 () indicates per cent leaf area removed during lopping.

Fig. 2



Effect of lopping intesities on net increment in dry matter of *Alnus glutinosa*. Bar indicates least significant difference at P - 0.05. () indicates per cent leaf area removed. LO - Control (O), L1-30 (28)%, L2-60 (56)% and L3-90(80)% lopping intensities.

Table 4

Effect of lopping intensities on net assimilation rate relative growth rate and shoot: root ratio (Days after lopping)

Lopping intensities (Actual leaf area removed)	Net assimilation rate (mg/cm^2/day)			Relative growth rate (g/g plant Weight/day)			Shoot : Root ratio		
	30	60	90	30	60	90	30	60	90
Control (0)	5.45	5.38	18.17	2.61	3.07	9.20	2.23	1.92	1.36
30(28) %	6.58	6.37	11.26	1.93	3.40	9.50	1.96	2.20	1.40
60(56) %	7.20	4.72	12.97	1.61	1.67	10.53	2.08	1.80	1.51
90(80) %	10.94	4.67	11.29	1.57	1.33	8.50	2.03	2.02	2.11
LSD (P = 0.05)	2.661			0.679			0.750		

LSD - Least significant difference

activity was done on Beckman Liquid Scintillation System after keeping the vials in dark for 18 hours. The activity in fresh sample were converted to dpm/g dry matter and 14 C-specific activities in shoot and roots were computed from the activities recorded in different plant parts. Per cent 14 C-photosynthate translocated into a plant part was computed from the 14 C specific activity in that part of the plant and the total 14 C- specific activity in the whole plant. (b) 16 plants were exposed to 14 CO_2 at 50 days after lopping. The procedures of 14 CO_2 exposure and analysis were followed as described earlier (a). The data were analysed in a randomized block design by taking lopping treatments X position of branch exposed to 14 CO_2 X stages of the exposure as treatment combinations with two replications.

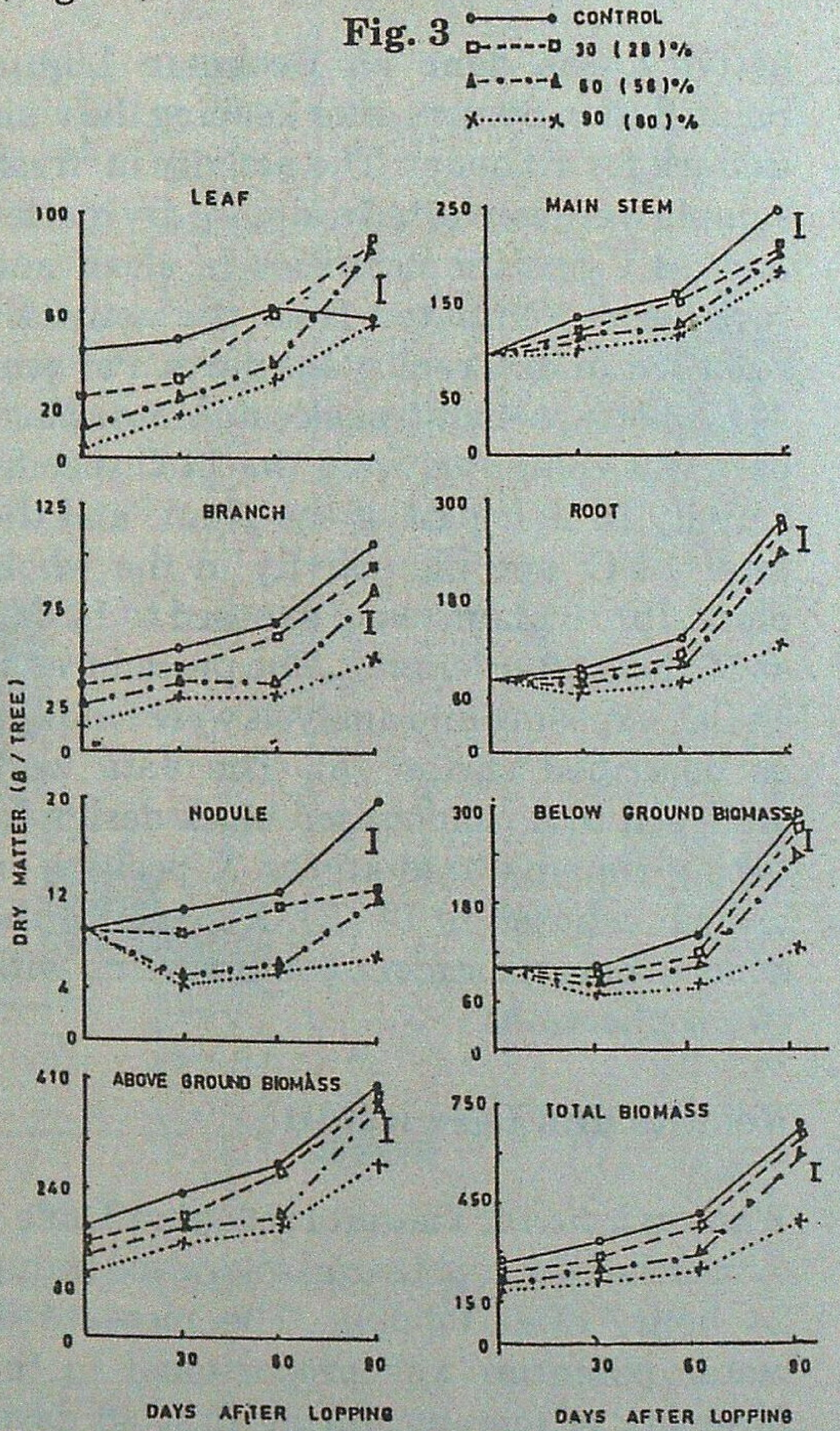
Results and Discussion

Water relations : The data set out in Table 1 evince that water potential was raised within 24 hours after lopping. The increase in water potential was proportional to the intensity of lopping during first 48 days. Thereafter, *A. glutinosa* showed no significant variations due to lopping treatment. The improvement in hydration of the lopped plants during early stages could be assigned to reduced transpiration rate per plant brought about by the reduced leaf area due to lopping (Table 2). It was observed that the transpiration rate decreased by 23, 56 and 80% at 30, 60 and 90 per cent lopping intensities, respectively, within 24 hours. The difference in transpiration rate narrowed down with the recovery of the leaf area. The water use efficiency during first 30 days reflected the improved hydration of the lopped plants (Table 3). The plant lopped at 30 per cent intensity recorded higher water use efficiency than the unlopped and those lopped at 60 and 90 per cent intensities. However, this difference in water use efficiency disappeared at 90 days after lopping. The improvement in water use efficiency of the plants lopped at 30 per cent intensity may be attributed to higher conductance of the remaining leaves which presumably boosted the rate of photosynthesis than the unlopped plants (Blake and Tschaplinski, 1986). The plants lopped at 60 and 90 per cent intensities had fewer remaining leaves than the 30 per cent lopped plants. Hence, the former could not attain higher water use efficiencies inspite of improved hydration of the plants than the unlopped plants.

Regrowth : The mechanism of regrowth in *A.glutinosa* was mainly through the recovery of larger leaf area than the unlopped plants and the increased net assimilation rate during first 30 days (Fig. 1, Table 4). It was observed that the plants lopped at 30 and 60 per cent intensities attained 62 and 57% more leaf area, respectively, than the unlopped plants. This was possible largely through the delayed leaf senescence in the lopped plants and the priority of these plants to invest more photosynthate for leaf drymatter production than the unlopped plants (Fig. 2, Table 4). Partial defoliation stimulated leaf growth in *Ceratopetalum apetalum* and *Diospyros melanoxylon* (Kotwal, 1981; Lowman, 1982). In the present study, leaf area increased by 1.4, 3.8, 5.5 and 6.8 times after lopping over the initial leaf area on the plants at 0 (unlopped), 30, 60 and 90 per cent intensities, respectively. However, an increase in the lopping intensity delayed the recovery of total leaf area. Nakano (1977) reported that in most species of deciduous plants, total leaf area of a defoliated plant exceeds that of an undefoliated one in the first year unless the defoliation is made towards the end of growing season.

Net assimilation rate increased during first 30 days as the lopping intensity was increased (Table 4). However, relative growth rate commensurate with the leaf area development under various lopping treatments. As a consequence, the plants lopped at 30 per cent intensity and the unlopped plants demonstrated higher relative growth rates than those lopped at 60 and 90 per cent intensities at 60 days and the plants lopped at 60 per cent utensity recorded highest relative growth at 90 days (Table 4). Shoot : root ratio tended to increase gradually with increasing intensity of lopping at 90 days after lopping (Table 4). Although the difference in the ratios was significant only between the plants lopped at 90 per cent intensity and the unlopped one but the gradual increase in the shoot : root ratios indicated that the lopped plants expended more photysythate on shoot growth than the unlopped plants (FitGerald and Hoodinott, 1983). Moreover, possible utilization of root carbohydrates were indicated by a net loss of root dry matter in the plants lopped at 60 and 90 per cent intensities during first 30 days after lopping (Fig. 2). Translocation of root stored

Fig. 3



Effect of lopping intensities on dry matter yield in different parts of *Alnus glutinosa*. Bar indicates least significant difference (LSD) at P - 0.05. () indicates per cent leaf area removed.

Table 5

Effect of lopping intensities on net increment in nodules

Lopping intensities (Actual leaf area removed)	Net increment in nodule dry matter (g/tree) Days after lopping 30	60	90
Control (0)	1.6	1.5	7.5
30(28) %	-0.4	2.4	1.4
60(56) %	-4.1	1.0	5.8
90(80) %	-4.5	1.2	1.0
LSD (P = 0.05)	2.56		

LSD - Least significant difference.

carbohydrates to the shoot of defoliated plants had been found by various workers (Parker and Houston; 1971, Detling *et al.*, 1979; Richard and Caldwell, 1985; Wargo *et al.*, 1972).

Net dry matter accumulation : The plants lopped at 60 per cent intensity accumulated maximum amount of dry matter (Fig. 2). Most of the dry matter (84.2%) in these plants accumulated during 60 to 90 days after lopping. The lower amount of dry matter accumulated by the unlopped and 30 per cent lopped plants could be partly assigned to mutual shading of leaves on a plant than those lopped at 60 per cent intensity (Verkaar, 1988). The plants lopped at 90 per cent intensity accumulated lowest amount of dry matter due to limited leaf area developed late in the season.

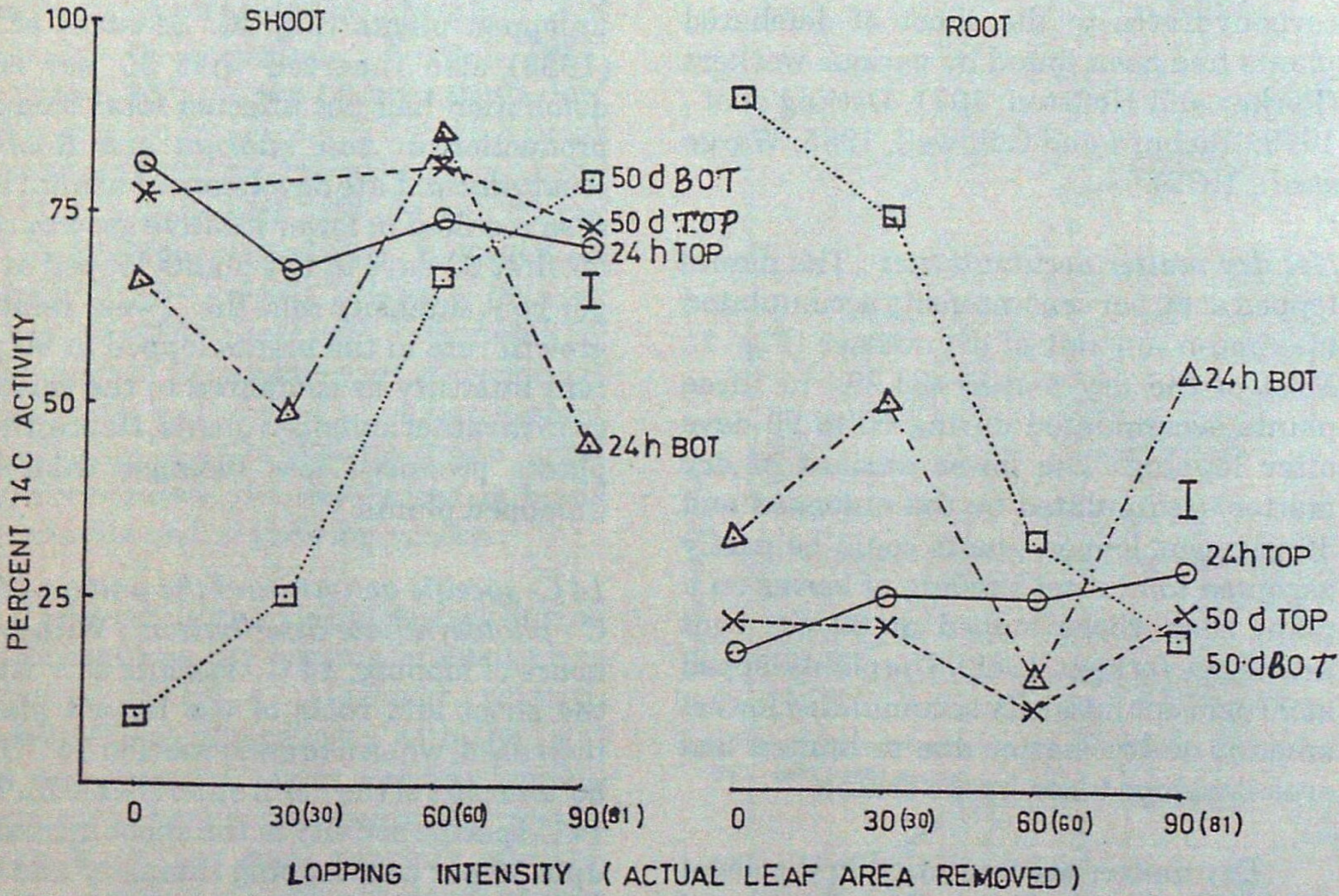
Dry matter accumulation in the shoot of lopped plants was largely on account of accelerated leaf growth (Fig. 2). Roots of the plants lopped at 30 and 60 per cent intensities accumulated dry matter similar to the unlopped plants. However, there was a loss of dry matter in the roots and nodules of the plants lopped at 60 and 90 per cent intensities during first 30 days after lopping. Dry matter accumulation in the nodules of the plants lopped at various intensities continued to be slower than the unlopped plants (Table 5). The adverse effect of 50 and 100 per cent defoliation was also reported on the nodulation of *Alnus incana* (Hus-Dannel and Sellstedt, 1983, 1985). They reported strong correlation between nodule growth and leaf area.

Total biomass : Early recovery and the larger leaf area attained by the plants lopped at 30 per cent intensity than other lopping treatment , resulted in total biomass production equivalent to that produced by unlopped plants (Fig. 3). Seastedt *et al.* (1983) also reported that 30 per cent defoliation had not affected total biomass production in *Acer rubrum* and *Robinia pseudocacia*. Late development of total leaf area resulted in lower relative growth rate for first 60 days in the plants lopped at 60 per cent intensity and the lowest relative growth rate in the plants lopped at 90 per cent intensity as compared to the relative growth rate of unlopped plants. Hence, these plants produced less biomass than the unlopped plants.

14 C- specific activity and the pattern of 14 C - photosynthate distribution : Within 24 hours of lopping, 14 C - specific activity in the shoot and roots of the lopped plants increased, when a branch was fed 14 CO_2 at bottom part of the main stem (Table 6). The 14 C-specific activity in the shoot increased upto 60 per cent lopping intensity and the specific activity increased upto 30 per cent lopping intensity, when a branch was fed 14 CO_2 at top part of the main stem 14 C-specific activity in the shoot increased with an increase in lopping intensity and in the roots, it increased as compared to the unlopped plants. The plants lopped at 30, 60 and 90 per cent intensities did not show difference in the 14 C-specific activities of the roots. The increase in 14 C-specific activity of lopped plants may be attributed to reduced sink size of the whole plant as compared to the sink size of unlopped plants. Most of the growing vegetative buds were clipped off during lopping. After some defoliation (50 days after lopping), the trend of change in 14 C-specific activities of the plants under different lopping treatments continued to be similar to those found at 24 hours after lopping.

Within 24 hours of lopping, a greater percentage of 14 C-photosynthate was translocated to roots and less to shoot of the lopped plants (Fig. 4). In general, less translocation of 14 C-photosynthate to different parts of the shoot was possibly a consequence of reduced sink size of the lopped plants. Unlike lopping, a greater percentage of 14 C-photosynthate was translocated to the expanding shoot of

Fig. 4



24 h- 14 CO_2 fed 24 hours after lopping.
50 d- 14 CO_2 fed 15 days after lopping.
Bot - a branch fed 14 CO_2 at bottom part of the main stem
Top - a branch fed 14 CO_2 at top part of the main stem.

Changes in 14 C - photosynthate distribution in shoot and root of *Alnus glutinosa* as influenced by lopping intensities. Bar indicates least significant difference (LSD) at P = 0.05. () indicates leaf area removed during lopping.

Table 6

Effect of lopping intensities on 14 C-specific activity in shoot and root

Lopping intensities (Actual leaf area removed)	14 C-specific activity (d pm/g dm)			
	Shoot		Root	
	24 h	50 d	24 h	50 d
14 CO_2 exposure to a branch at bottom part of the main stem				
Control (0)	9.97	1.04	5.03	8.22
30(30) %	11.85	5.20	16.19	16.52
60(59) %	13.41	1.57	3.71	0.84
90(80) %	4.30	3.40	6.50	1.20
14 CO_2 exposure to a branch at top part of the main stem				
Control (0)	16.57	20.31	4.88	5.27
30 (31) %	15.16	9.14	12.77	3.77
60 (60) %	23.13	19.00	10.88	4.68
90 (82) %	28.16	26.43	10.92	10.75
LSD (P = 0.05)	2.29		1.23	

24 h - 14 CO_2 exposure 24 hours after lopping. 50 d - 14 CO_2 exposure 50 days after lopping.
LSD - Least significant difference.

Table 7

Effect of lopping intensities on percentage 14 C-photosynthate in nodules

Lopping intensities (Actual leaf area removed)	Per cent 14 C-activity	
	24 hours	50 days
14 CO_2 exposure to a branch at bottom part of the main stem		
Control (0)	23.96 (29.30)	14.98 (22.79)
30(30) %	25.66 (30.43)	8.79 (17.26)
60(59) %	26.71 (30.63)	1.98 (8.13)
90(80) %	30.23 (33.35)	8.75 (17.26)
14 CO_2 exposure to a branch at top part of the main stem		
Control (0)	8.02 (16.64)	10.68 (19.09)
30 (31) %	17.38 (24.65)	4.20 (11.83)
60 (60) %	12.88 (21.05)	2.62 (9.28)
90 (82) %	17.85 (25.03)	3.35 (10.63)
LSD at (P = 0.05)	(2.11)	

24 hours 14 CO_2 exposure was given 24 hours after lopping
50 days 14 CO_2 exposure was given 50 days after lopping
() - Angular value Arc sine$\sqrt{\text{per cent}}$), LSD - Least significant different.

partially defoliated *Populus euramericana* within 24 hours of defoliation (Bassam and Dickmann, 1985). This difference between defoliation and lopping was probably due to removal of source (leaf area) only in the case of defoliation and source as well as sink (growing vegetative buds) in the case of lopping. When the remaining buds on the lopped plants started growing at 50 days after lopping, a greater percentage of 14 C-photosynthate was translocated to the shoot of lopped plants as compared to the shoot of unlopped plants, when 14 CO_2 was fed to a branch in the bottom part of the main stem (Fig. 4). The percentage of 14 C-photosynthate translocated to the shoot increased with increasing lopping intensity. Similar trend was evident for leaf growth in Experiment I. This showed increased utilization of current assimilate for leaf growth (Bassam and Dickmann, 1985). Pattern of translocation of 14 C-photosynthate to the nodules under various lopping treatments showed that within 24 hours of lopping, a greater percentage of 14 C-photosynthate was translocated to the nodules of lopped plants and less to the nodules of unlopped plants, particularly when 14 CO_2 was fed to a branch at the top part of the main stem (Table 7). At 50 days after lopping, the trend reversed and a greater percentage of 14 C-photosynthate was translocated to the nodules of unlopped plants than the nodules of lopped plants.

SUMMARY

A study on the effect of four lopping intensities (0, 30, 60 and 90 %) was made on three years old *Alnus glutinosa* (L.) Gaertn. It was observed that the reduction in leaf area led to a corresponding decline in transpiration rate after lopping. Consequently, there was an increase in water potential upto 48 days. The raised water potential enhanced water use efficiency particularly during first 30 days. Lopping at 30 and 60 per cent intensities led to 62 and 57% more leaf area on the lopped plants than the unlopped ones. Regrowth in *Alnus glutinosa* was found to be related to a combination of higher net assimilation rate during first 30 days, recovery of larger leaf area, delayed leaf senescence and use of current and root stored carbohydrates (particularly at 60 and 90% lopping intensities) for leaf growth. Unlike defoliation, a greater percentage of 14 C-photosynthate were translocated to the roots than to the shoot of the lopped plants within 24 hours after commencement of lopping treatment but the established course of translocation of photosynthate identical to defoliation commenced at 50 days after lopping. At this stage, a greater percentage of 14 C-photosynthate was translocated for the growth of shoot and less to the roots of the lopped plants, when a branch at bottom part of the main stem was fed 14 CO_2. The plants lopped at 30 per cent intensity produced total biomass equivalent to the unlopped plants due to relatively quick resumption of total leaf area than those plants lopped at 60 and 90 per cent intensities. Lopping treatments adversely affected dry matter accumulation in the nodules.

एल्नस ग्लुटिनोसा की जल धारण संभाविता, पुनर्वृद्धि, 14-कार्बन फोटोसिन्थेटेट वितरण और जैवपुजं उत्पादन पर अधिकृन्तन (झंगाई) चण्डताओं का प्रभाव

के०ए० सिहं व एफ०बी० थौम्पसन

सारांश

एल्नस ग्लुटिनोसा (ली०) गार्टन के 3 वर्षीय पादपों पर झंगान की चार चण्डताओं (0, 30, 60 और 90%) के प्रभाव का अध्ययन किया गया । देखने में यह आया की पर्ण क्षेत्र में कमी हो जाने से झंगान करने के पश्चात् वाष्पोत्सर्जन दर में तदनुरूप

कमी आई। फलस्वरूप, जल धारण संभाविता में 48 दिनों तक की वृद्धि हुई । बढ़ी हुई जल संभविता से जलोपयोग दक्षता, विशेषतः पहले 30 दिनों मे, भी वृद्धि हुई । झंबगान 30 और 60% चण्डता वाला करने पर बिना झंगान किए पादपों की तुलना में झंगान किए वृक्षों का पर्ण क्षेत्र 62 और 57% अधिक रहा । काले एल्डर में हुई पुनवृद्धि का संबन्ध पहले 30 दिनों में शुद्ध अधिक सात्मीकरण दर, बड़े पर्णक्षेत्र की फिर से प्राप्ति, पर्ण जीर्णता में विलम्ब और पर्ण वृद्धि के लिए वर्तमान और जड़ों मे जमा हुए कार्बोहाइड्रेट (विशेषत 60 और 90% अधिकृन्तन चण्डताओं में) के मिलेजुले प्रभावों से पाया गया । निष्पत्रण होने के विपरीत 14-कार्बन फोटोसिन्थेटेर का अधिकाशं प्रतिशत् अधिकृन्तन उपचार शुरू होने के पश्चात 24 घंटों के अन्दर झंगान किये पादपों के प्ररोहों के बजाए उसकी जड़ों में स्थानान्तरित हो गया परन्तु निष्पत्रण के पश्चात फोटोसिंथेटेट स्थानान्तरण होने का उसके समान जमा-जमाया ग्रम झंगान के 50 दिन बाद ही शुरू हुआ । इस स्थित में 14-कार्बन सिन्थेटेट का अधिकांश प्रतिशत झंगान किए पादपों में प्ररोहों की वृद्धि के लिए और कम प्रतिशत् जड़ों की वृद्धि के लिए स्थानान्तरित हुआ । जब प्रधान तने के निचले भाग की शाखा को 14 सीओ$_2$ से पोषित किया गया । 60 और 90 प्रतिशत् चण्डता पर अधिकृन्त पादपों की तुलना में 30% चण्डता पर झंगान किए पादपों में बिना झंगान किए पादपों के बराबर ही जैवपुंज उत्पन्न हुआ क्योंकि उनका पूर्ण क्षेत्र बहुत शीघ्रता से उनकी अपेक्षा कहीं अधिक पहले जैसा बन गया था । झंगान उपचारों का ग्रन्थाओं में शुष्क पदार्थ जमा होने पर कुप्रभाव पडा ।

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PHYSICAL AND MECHANICAL PROPERTIES OF *EUCALYPTUS GRANDIS* AND *E. TERETICORNIS* GROWN IN KERALA

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Introduction

One main objective of Eucalypt plantation management in India particularly Kerala is pulpwood production. However, the diminishing supply of conventional timber now necessitates the utilisation of *Eucalypts* in solid wood uses like construction and furniture. This calls for adequate information on strength properties in the harvestable age to ascertain their suitability. Two extensively planted species are *Eucalyptus grandis* and *E. tereticornis*. Relatively little is known about the former while considerable data have been published for the latter (Sekhar and Rajput, 1968; Shukla *et al.*, 1989,1991; Rajput *et al.*, 1992). Yet, the information is still inadequate because of the fact that wood properties vary significantly with age and often with locality. This paper reports the data on physical and mechanical properties of 30-year-old *E. grandis* and 16-year-old *E. tereticornis* grown in Kerala.

Materials and Methods

Six dominant trees of *E. grandis* have been sampled in 30-year-old plantation raised in an upland (altitude of about 950 m) in Kerala (Vandiperyar). For *E. tereticornis* 16-year-old plantation was sampled in low elevation (Vallor, Trichur) in such a way that seven sample trees covered the different girth classes in the plantation.

Cross sectional discs of about 6 cm thickness were removed from the breast height level. Diametrical segments were cut from the discs and sample blocks of 2 x 2 x 5 cm size were prepared from the pith to the periphery to determine the initial moisture content, basic specific gravity (green volume - o.d. weight ratio) and volumetric shrinkage from green to o.d. condition.

Mechanical testing: Three trees of *E. grandis* (EG) and six of *E. tereticornis* (ET) have been selected from the sampled trees for mechanical testing. The basal longs of 1.5 m meter length were converted into scantlings of 3x3 cm cross section to prepare the test samples from the pith to the periphery near the breast height level (1.37 m) in four radial directions. From two opposite radii, samples were tested for static bending (with the size of 2 x 2 x 30 cm) while the samples (size of 2 x 2 x 10 cm) for compression test in parallel to grain were collected from the other two opposite radii. The methods followed to carry out the tests are essentially the same as prescribed in IS: 1708 (Anon., 1986).

Results and Discussion

Physical properties : The tree size, as measured by the girth, appears to be large to very large for EG at the age of 30 years (Table 1). Because only dominant trees were selected the coefficient of variation of sampled trees is quite low. However, in ET at the early age of 16 years, between-tree girth variation was about 29% due to the sampling of different girth classes. The average heartwood percentages were 76.5% and 57.8% with relatively low between-tree variations (4-7%) in EG and ET respectively (Table 1). Basic specific gravity and volumetric shrinkage were lower and moisture content higher in the former than in the latter. As compared with the published data on younger wood, in both the species, age had greater effects on the increase of heartwood content than on the increase of specific gravity (Sekhar and Rajput, 1968; Purkayastha *et al.*, 1980; Bhat *et al.*, 1988, 1990; Shukla *et al.*, 1989, 1991; Rajput *et al.*, 1992).

Table 1

Physical properties of the sampled trees

Age (yr)	No. of trees (n)	GBH (cm)		Heartwood (%)		Initial moisture content (%)		Basic specific gravity		Volumetric shrinkage (%)
		Mean	CV %	Mean	CV %	Mean	CV %	Mean	CV %	
E. grandis										
30	6	142	7.5	76.5	5.4	93.1	12.1	0.532	8.1	14.5
E. tereticornis										
16	7	63	29.0	57.8	7.0	77.1	9.2	0.627	2.7	18.0

GBH = Girth at breast height under bark, CV = Coefficient of variation (between-tree)

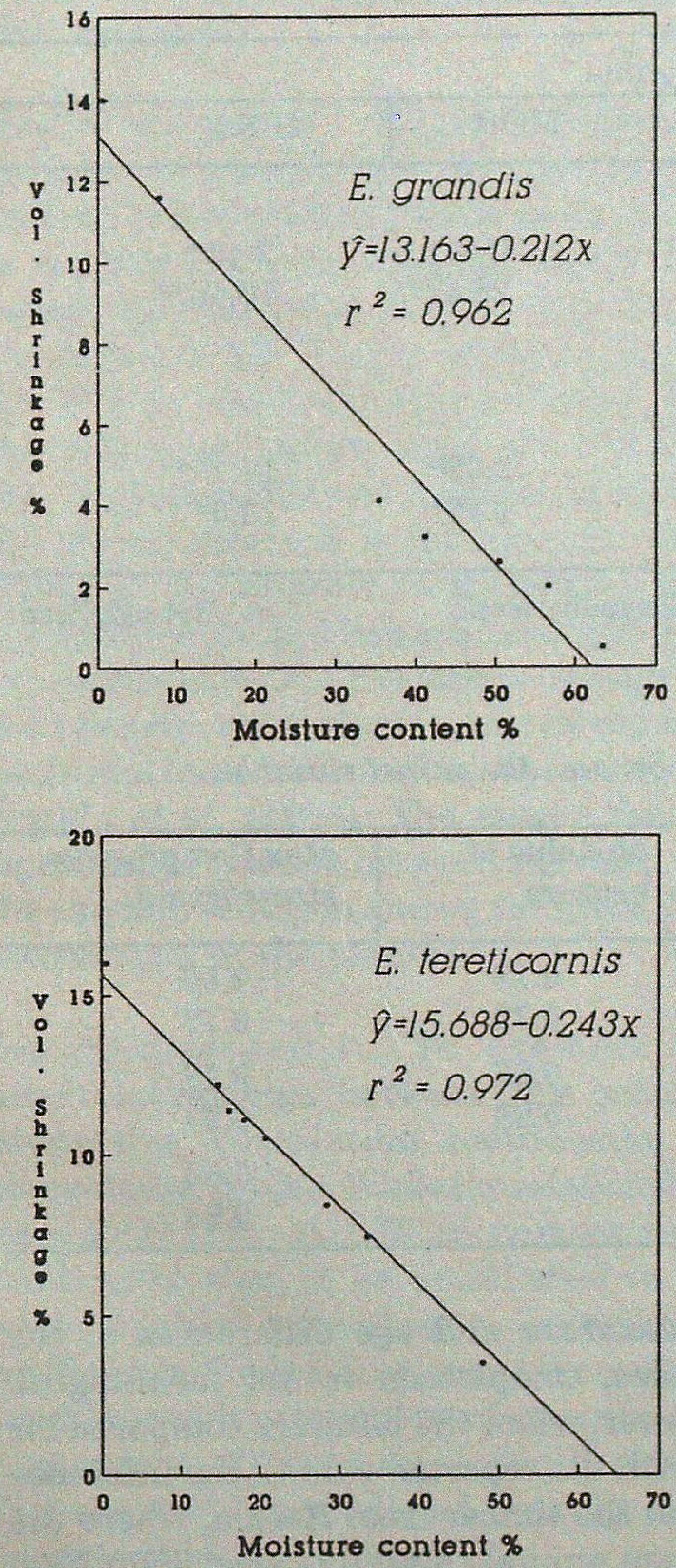
Table 2

Mean strength properties in two Eucalyptus in comparison with mature Teak

Moisture content (%)	Specific gravity (A.D.)	Static bending kg/cm²			Compressive stress kg/cm²
		FS-EL	MOR	MOE	Parallel to Grain
E. grandis (30-year-old)					
18.0	0.602	429	836	111, 732	356
E. tereticornis (16-year-old)					
13.8	0.745	480	881	98, 721	429
Tectona grandis (> 60 years)*					
--	0.650	--	959	119, 600	532

FS-EL = Fibre stress at proportional limit
MOE = Modulus of Elasticity
MOR = Modulus of Rupture
* (Nazma *et al.*, 1981)

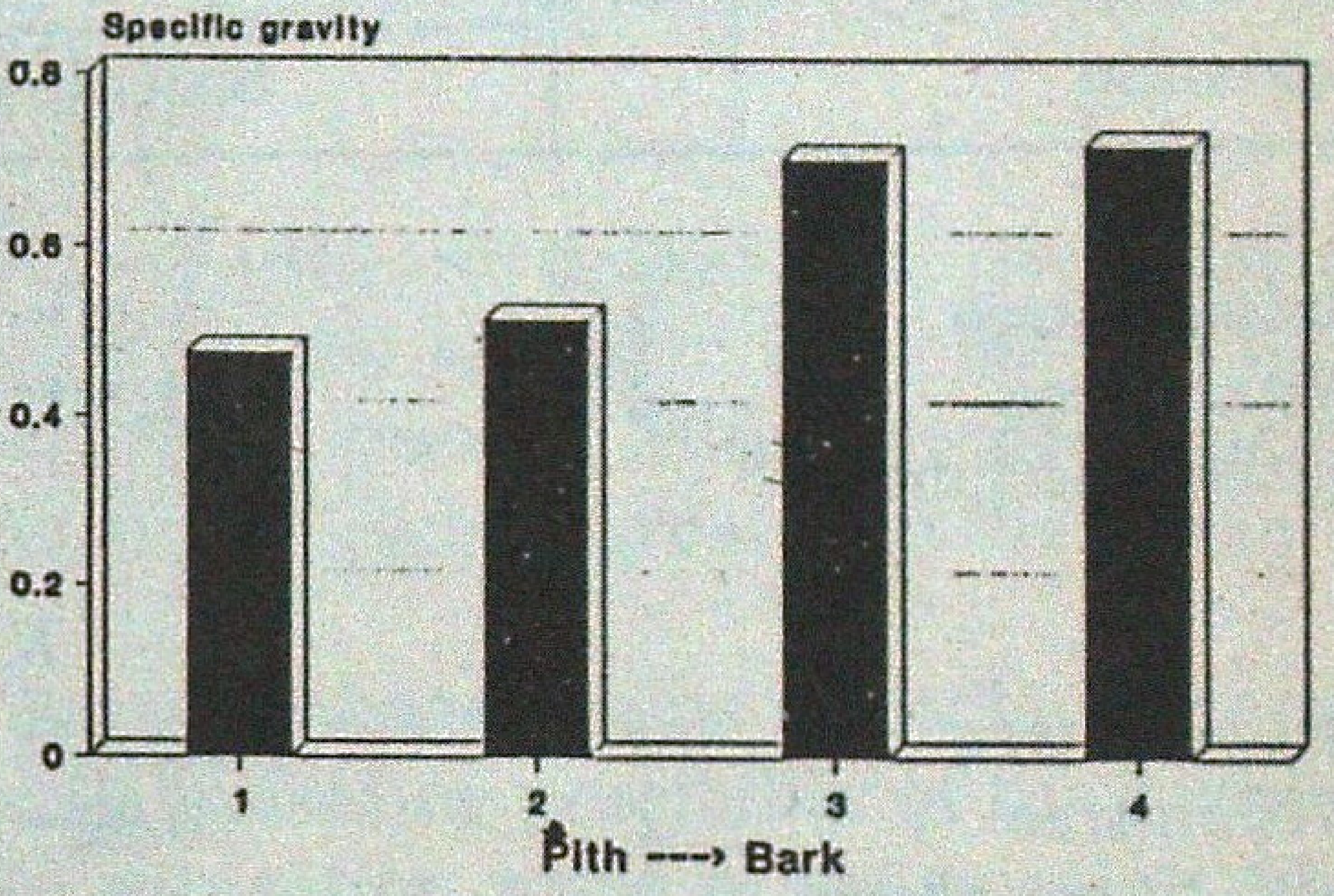
Fig. 1



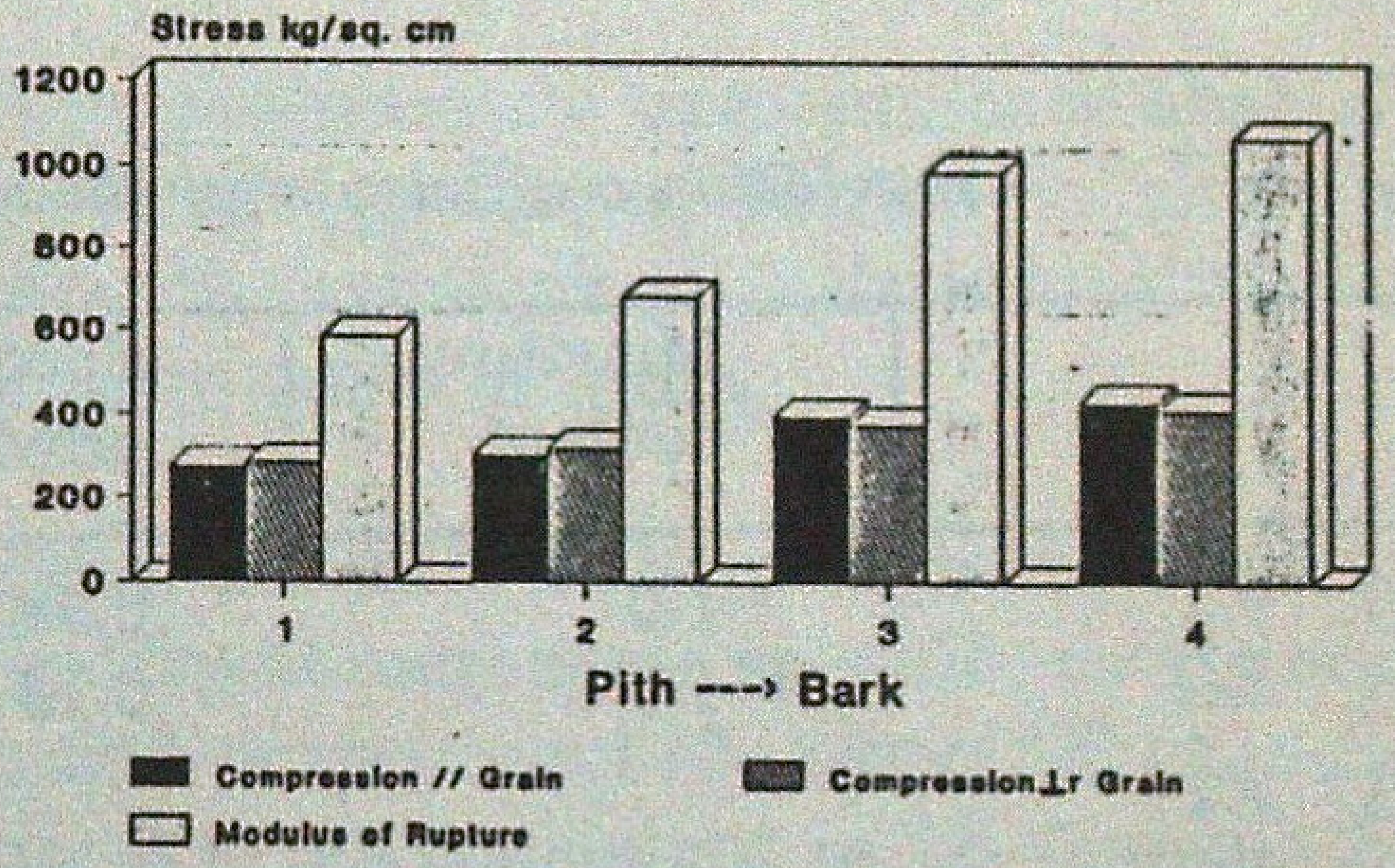
Volumetric shrinkage as a function of moisture content.

Fig. 2

(a) Specific gravity variation



(b) Strength variation



Specific gravity (a) and strength values (b) in relation to the position from pith to periphery in *E. grandis*.

Based on the sampling of six trees of EG and seven of ET, the approximate fibre saturation point was estimated by the shrinkage intersection point obtained by plotting the linear pattern of volumetric shrinkage against the moisture content and extrapolating this line to zero shrinkage (Kelsey, 1956). This is indicative of relatively high fibre saturation point possibly lying above the level of 30-35% (Fig. 1) due to the juvenility of the timber. However, more studies are necessary to present the exact value of fibre saturation point.

Between-species variation : Mechanical test results show that timber of ET even at the very young age of 16 years is denser and stronger than that of 30-year-old EG. However, these species show about 80-95%

Table 3

ANOVA of selected physical and mechanical properties

Source of variation	d.f	F-value		
		Specific gravity	MOR	MCS //
		E. grandis		
Between-tree	2	1.11^{ns}	0.84^{ns}	2.46^{ns}
Within-tree (pith-to-periphery)	3	46.30**	28.47**	18.16**
		E. tereticornis		
Between-tree	3	16.74**	2.08^{ns}	14.1**
Within-tree (pith-to-periphery)	2	0.92^{ns}	1.35^{ns}	13.0*

** Significant at 1% probability level, * Significant at 5% probability level, ns - Not significant.

Table 4

Correlation coefficients for the relationships between the paired variables

		Moisture content	Specific gravity	Modulus of rupture	Max.Compressive stress//grain
(1)	ET	1.0	0.58	0.18	0.66
	EG	1.0	0.73	0.72	0.77
(2)	ET			0.06	0.73
	EG			0.98	0.93
(3)	ET				0.55
	EG				0.94

of the bending and 66-81% of the compression (parallel to grain) strength values of mature teak (Table 2) indicating their suitability for solid wood uses (Bhat 1992).

Between-locality differences : No adequate data are available for EG to compare the strength between the localities except with the results reported from Dehra Dun for 14-year-old green wood (Shukla *et al.*, 1989). Although, MOR and MCS values of the present study are greater than those of the timber tested from Dehra Dun because of the mositure and age differences of the samples, comparison is not meaningful. However, when the data are compared for ET with the reported values, the inference is that the timber from Kerala, where the average annual rainfall is abut 2500-3000 mm, is at least 11% weaker in static bending and 4% in crushing strength, than that of almost similar age tested from Panjab and Haryana (Rajput *et al.*, 1992). A small difference even between the neighboring States like Punjab and Haryana was noted by Rajput *et al.* (1992). The probable explantion for this between-locality variation is that *Eucalyptus* produce less dense and weaker timber in wet localities that arid zones.

Radial variation : Radial patterns of variation in specific gravity and bending and compression strengths show that there is marked increase from the pith to the periphery in EG (Fig. 2) while they are not consistent in ET. This is evident from the ANOVA as tested the four positions from the pith-to-periphery while the between-tree variation was not significant among the three selected dominant EG trees (Table 3). In contrast radial variation in specific gravity and bending strength were not significant in ET because at this age the peripheral position shows lower values after the initial increase from the pith as noted by Shukla *et al.* (1988). The reason for the significant variation between the trees was the random selection among the girth class distribution in the plantation.

Interrelationships : To examine the interrelationships between the selected properties, correlation coefficients are presented in Table 4. While the relationships were not consistent in ET, more meaningful relationships could be established in EG with highly significant correlation coefficients. For instance, moisture content, specific gravity, modulus of rupture and compressive stresses are so closely related that one could be predicted from the other because of high r^2 values.

Conclusions

From the test results of the present study the following conclusions may be dawn.

1. The 16-year-old timber of *E. tereticornis* is denser and stronger than 30-year-old timber of *E. grandis* although modulus of elasticity is slightly greater in the latter.

2. The shrinkage begins at early stage of drying indicating possibility of the higher fibre saturation point of these relatively young timbers than the conventional value of 30% moisture content.

3. The preliminary data indicate that *E. tereticornis* grown in Kerala is slightly weaker than that grown in drier localities of Northern parts of India.

4. From the pith to the periphery, there is a significant increase in specific gravity and strength properties of 30-year-old *E. grandis* while it is not consistent in 16-year-old *E. Tereticornis* as the wood near the bark region often shows slight lower values than in the intermediate position between pith and bark regions.

5. The interrelationships among the specific gravity, bending and compression strengths are so strong in *E. grandis* that one could be predicted from the other. In contrast, in the younger *E. tereticornis* the interrelationships are rather weak.

Acknowledgements

We are grateful to Dr. S. Chand Basha, I.F.S. the then Director for his encouragement and valuable suggestions. Thanks are due to Mrs. P. Rugmini for the computerised statistical analysis and Mr. Ramakrishnan for graphics.

SUMMARY

Physical and machenical testing of 30-year-old *Eucalyptus grandis* and 16-year-old *E. tereticornis* reveals that timber of the former is lighter and weaker than the latter. Shrinkage appears to begin in the early stage of drying when the moisture content is above 50-60%. Both the species show about 80-95% of the bending and 66-81% of the compression (parallel to grain) strength values of mature teak indicating their suitability for solid wood uses. As compared with the reported values of bending strength, *E. tereticornis* is found about 11% weaker than that grown in drier localities of North India.

केरल में उगाए *युकेलिप्टस ग्रांडिस* और *यु० टेरेटिकार्निस* की भौतिक और संधारिक विशेषताएँ

के०एम० भटट्‌ व पी०के० तुलसीदास

सारांश

30 वर्षीय *युकेलिप्टस ग्रांडिस* और 16 वर्षीय *यु० टैरेटिकार्निस* के भौतिक और संधारी परिक्षणों से पता चला है कि बाद वाले की तुलना में पहला अधिक हल्का और कमजोर रहता है । सिकुड़ना सुखने की प्रारम्भिक अवस्था में ही शुरू हो जाता प्रतीत हो जाता है जब नमी तत्व 50-60% के अधिक रहता है । दोनों जातियों की नमन अर्हा लगभग 80-95% और (सुत्र के समानान्तर) संपीड़न शक्ति अर्हा वयस्क सागौन की 66-81% ज्ञात हुई है जो ठोस काष्ठ जैसे उपयोग के लिए उनकी उपयुक्तता के लिए सूचक है । नमन शक्ति की सूचित अर्हाओं की तुलना में यहाँ के *यु० टेरेटिकार्निस* की अर्हाएँ उत्तरी भारत के शुष्कतर स्थानों में उगे हुए वृक्षों की तुलना में लगभग 11% कम शक्ति वाले पाए गए हैं ।

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GENETIC ENHANCEMENT AND MASS PRODUCTION OF QUALITY PROPAGULES OF *BAMBUSA NUTANS* AND *DENDROCALAMUS MEMBRANACEOUS*

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Introduction

Bomboo is one of the economically important multipurpose, fast growing plant species used as raw material for paper and pulp making, handicrafts, construction materials and food (Banik, 1995). Because of its extensive usage and unique flowering habit bamboo is now depleted over a large part of the world. Since the conventional methods of propagation cannot provide the propagules in required quantities, development of efficient *in-vitro* methods become necessary for the establishment of new bamboo plantations. Though the success in tissue culture was reported for many bamboo species the technology is implemented commercially only for few species like *Dendrocalamus strictus* (Zamora, 1994). Hence efforts were taken upto develop a commercially viable technology for mass propagation of *Bambusa nutans* and *Dendrocalamus membranaceous*. *Bambusa nutans* is a thick walled species, the culms are not densely clustered. The culms growth to a height of 15 m. It is very common in India and Nepal and also cultivated in Bangladesh. So far, there is no report available on tissue culture of this species. *Dendrocalamus membranaceous* is a thin walled bamboo, culms attaining a height of 18-21 m. The culms are useful in construction. It occurs in India, Sri Lanka, Thailand and Bangladesh (Banik, 1995).

Materials and Methods

Bambusa nutans seeds were obtained from Tropical Forest Research Institute, Jabalpur and *Dendrocalamus membranaceous* seeds were obtained from Kanchanaburi provenance of Thailand. The seeds of good physical quality in terms of size were culled (Gurumurthi *et al.*, 1995) dehusked and surface sterilized with 0.1% Savlon, 0.1% Sodium hypochlorite and 0.1% Mercuric chloride. After each sterilant use, the seeds were rinsed several times in sterile water. The sterilized seeds were placed on water agar medium with 2% Sucrose and incubated in light at 25°C to screen for inborn contamination. The seedlings without any contamination were used for the experiments. When the seedlings attained a height of 8-10 cm, the nodal segments were excised and placed in Murashige and Skoog media with following growth hormones :

(a) MS + 0.5 mg/l BA
(b) MS + 1.0 mg/l BA
(c) MS + 0.5 mg/l BA + 0.25 mg/l K
(d) MS + 1.0 mg/l BA + 0.5 mg/l K

(BA-Benzylaminopurine; K-Kinetin)

All the media were containing 2% sucrose, and pH adjusted to 5.0. Sub-culturing was performed in 15-20 days intervals. A bunch of 3-4 shoots were used for sub-culturing. Rooting experiments were carried out in MS medium with 2% sucrose, Indole Butyric Acid (IBA) 0.5 and 1.0 mg/l and Naphthyl Acetic Acid (NAA) 0.5 and 1.0 mg/l. After 48 hours of treatment in rooting medium, the cultures were transferred to MS half strength medium without hormones.

Results and Discussion

Seeds of *Bambusa nutans* and *Dendrocalamus membranaceous* were germinated on agar medium showed 40% and 60% bacterial infection and 5% and 7% fungal infection respectively. Previous report on seed microflora also indicated the presence of bacterial and fungi in stored seeds of *Bambusa arundinacea* and *Dendrocalamus strictus* (Mohanan, 1988). Shoot multiplication was evident within a week, but the rate of multiple shoot production was low for first few subcultures.

After 3 to 4 subculture the rate of proliferation was high (Table 1) and the MS medium with 0.5 mg/l BA showed better multiplication (23 shoots/flask in case of *Dendrocalamus membranaceous* and 18.5 shoots/flask in case of *Bambusa nutans*). Higher concentrations of cytokinins suppressed the rate of multiplication. However, Prutpongse and Gavinlertvatana (1992) reported that 5.0 mg/l BA produced maximum number of multiple shoots. The per cent response of explants to produced

Table 1

Rate of shoot multiplication in different cytokinin levels

Growth regulators (mg/l)	Mean ±S.E. No. of shoots		Mean ±S.E. shoot length		Per cent response of explants	
	B.n	D.m	B.n	D.m	B.n	D.m
BA 0.50	18.5 ± 1.2	23.0 ± 1.6	6.2 ± 0.7	8.5 ± 1.8	82	80
1.00	12.8 ± 1.1	17.5 ± 1.3	4.5 ± 0.8	7.2 ± 1.5	72	58
BA 0.50 K 0.25	14.2 ± 0.9	19.3 ± 1.5	4.2 ± 0.2	2.8 ± 1.5	63	32
BA 1.00 K 0.50	7.3 ± 0.9	5.1 ± 0.6	4.8 ± 0.8	5.7 ± 0.8	48	35

Table 2

Rate of root production in different auxin levels

Growth regulators (mg/1)	Per cent rooting		Mean±S.E. No. of roots		Mean±S.E. root length		Per cent survival	
	B.n	D.m	B.n	D.m	B.n	D.m	B.n	D.m
IBA 0.5	68	73	3.5 ± 0.8	4.2 ± 0.7	5.2 ± 0.7	7.2 ± 1.5	65	67
1.0	49	40	2.8 ± 0.4	2.7 ± 0.6	4.5 ± 1.2	4.8 ± 0.8	33	47
NAA 0.5	56	53	2.0 ± 0.3	1.8 ± 0.4	1.2 ± 0.3	2.0 ± 0.3	36	40
1.0	35	27	1.5 ± 0.5	1.4 ± 0.3	0.9 ± 0.1	1.8 ± 0.2	10	27

(B.n - *Bambusa nutans*, D.m - *Dendrocalamus membranaceous*) multiple shoots was also high in 0.5 mg/l BAP. Since the degree of shoot proliferation depended on propagule size the subculturing was done in groups of 3-4 shoots. The shoots in groups of 3-4 with the length of 4.0 cm and above were used for rooting. The medium containing 0.5 mg/l IBA showed higher percentage of rooting, more number of roots and better survival rate (Table 2). The root length was also high in 0.5 mg/l IBA. Whereas, the roots produced in the medium containing NAA were thick and stunt. After 20 days in MS half-strength, the plants became ready for hardening. The plants were planted in vermiculite and hardened in polytunnel under shade house for 15 days then transferred to shade house.

Gurumurthi *et al*. (1995) showed that in *Bambusa arundinacea* seed quality and seedling vigour can be exploited in consonance with cost effective tissue culture techniques to mass produce quality planting materials. In the present study seed of good physical quality were used coupled with assessment for mass multiplication frequency. Thus, the practical objective of the present work was to assess number of propagules that could be produced from single bud. Using this technique 1069 plants of *Dendrocalamus membranaceous* and 967 plants of *Bambusa nutans* could be produced from a single axilary bud in 5-6 months. The number of propagules can be scaled up by a factor of atleast 4 in another six months using macro-proliferation method described by Adarsh Kumar (1991, 1992). The propagules produced have been transferred to field for evaluation. Further, the mass multiplication method has also been transferred to commercial tissue culture laboratories.

Most of the micro-propagation reports on Bamboo used seeds or seedling tissues as explants (Zamora, 1994). However, Gurumurthi *et al*. (1995) demonstrated that genetic enhancement is possible through upgradation of the planting material by identifying vigorous phenotypes and grading of seeds obtained from them. The method used for *Bambusa arundinacea* can also be adopted for genetic enhancement of all other bamboos using seed selection cum mass multiplication strategies in order to increase yield per unit area. This method also provides technology for continuous availability of quality propagules for many years after the seed availability ceases.

SUMMARY

Bench scale method for commercial propagation of*Bambusa nutans* and *Dendrocalamus membranaceous* was developed using seed quality and seedling vigour to mass produce quality propagules. Multiple shoots were produced from nodal segments of aseptically grown seedlings, cultured on Murashige and Skoog medium containing BA. Rooting was done in 0.5 mg/l BA. This method produced 967 plants of*Bambusa nutans* and 1069 plants of*Dendrocalamus membranaceous* in the span of 5-6 months which can be scaled up four times through macroproliferation.

आनुवंशिकीय सुधार और *बैम्बुसा न्यूटांस* और *डेण्ड्रोकैलेमस मेम्ब्रेनेसियस* के गुणों वाले प्रवर्धों का पुजोंत्पादन

आर० यशोदा, आर० सुमति, पी० मल्लिगा व के० गुरुमुर्ति

सारांश

गुणों वाले प्रवर्धों का पुंजोंत्पादन करने के लिए बीज गुण और पौधों की ओजस्विता उपयोग में लाकर *बैम्बूसा न्यूटांस* और *डेण्ड्रोकैलेमस मेम्ब्रेनेसियस* के व्यावसायिक प्रवर्धन के लिए बेंच परिमाण रीति का विकास किया गया । प्रतिपूयिक उगाए पौधों के ग्रन्था खण्ड के बहुप्ररोह उत्पान्न किए गए जिन्हें मुराशिगे और स्कूग माध्यम पर वर्धित किया गया जिसमें बीज (ब्यूटरिक अम्ल) मिला था । जडें निकलना 0.5 मिग्रा लि० इण्डोल ब्यूटरिक अम्ल में कराया गया । इस विधि से 5-6 महीनों की अवधि में ही *बैम्बूसा न्यूटांस* के 967 तथा *डेण्ड्रोकैलेमस मेम्ब्रेनेसियस* के 1069 पौधे तैयार हो गए जिन्हें बृहतप्रर्वधन कराकर चार गुने तक बढाया जा सकता है ।

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BIOCONTROL OF DAMPING OFF OF *EUCALYPTUS TERETICORNIS* SM. USING ECTOMYCORRHIZAE

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Introduction

Damping off caused by *Pythium* is a serious problem in forest nurseries. The fungus upon infection ramifies into the meristematic and immature cortical tissue and eventually causes limited or extensive rotting. Careful management is therefore required to reduce this disease. Fungicides have to be applied in advance to reduce the infection. Unfortunately the application of fungicides and some of the nursery procedures often disturb the natural rhizospheric flora including mycorrhizal fungi (Molina, 1982) leading to increased attacks by opportunistic pathogens (Schwerdtfeger, 1981). Therefore by selecting appropriate mycorrhizal fungi for inoculation of nursery seedlings (Molina, 1982) would help not only to improve the growth of the seedlings but also to protect them against diseases.

Many ectotrophic mycorrhizal fungi are reported to be less inhibitory to soil pathogens both *in-vitro* and *in-vivo* through antibiosis, hyphal parasitism, presence of mechanical barriers etc. (Marx, 1969; Chakravarty and Unestam, 1987; Kope and Fortin, 1989). However, the antagonistic activity of *Rhizopogon leuteolus* Fr. and Nordh, has not been exploited for controlling any of the root pathogens either *in-vitro* or *in-vivo*.

Materials and Methods

The pathogen *Pythium aphanidermatum* (Eds.) Fitz. was isolated from young *E. tereticornis* Sm. seedlings affected by damping off in the nurseries of the Forest Research Station, Mettupalayam. The culture was maintained in PDA at room temperature. Sterile cork borers were used to remove fungal discs of 9 mm diameter from the periphery of a week old culture plate.

The ectomycorrhizal fungi : Ectotrophic mycorrhizal fungi viz. *Laccaria laccata* (Scop. ex Fr.) Berk. and Br., *Pisolithus tinctorius* (Pers.) Coker and Couch, and *R. leuteolus* were obtained from Forest Research Institute, Dehra Dun. Another isolate of *P. tinctorius* (isolate-2) was obtained from Department of Microbiology, TNAU, Coimbatore.

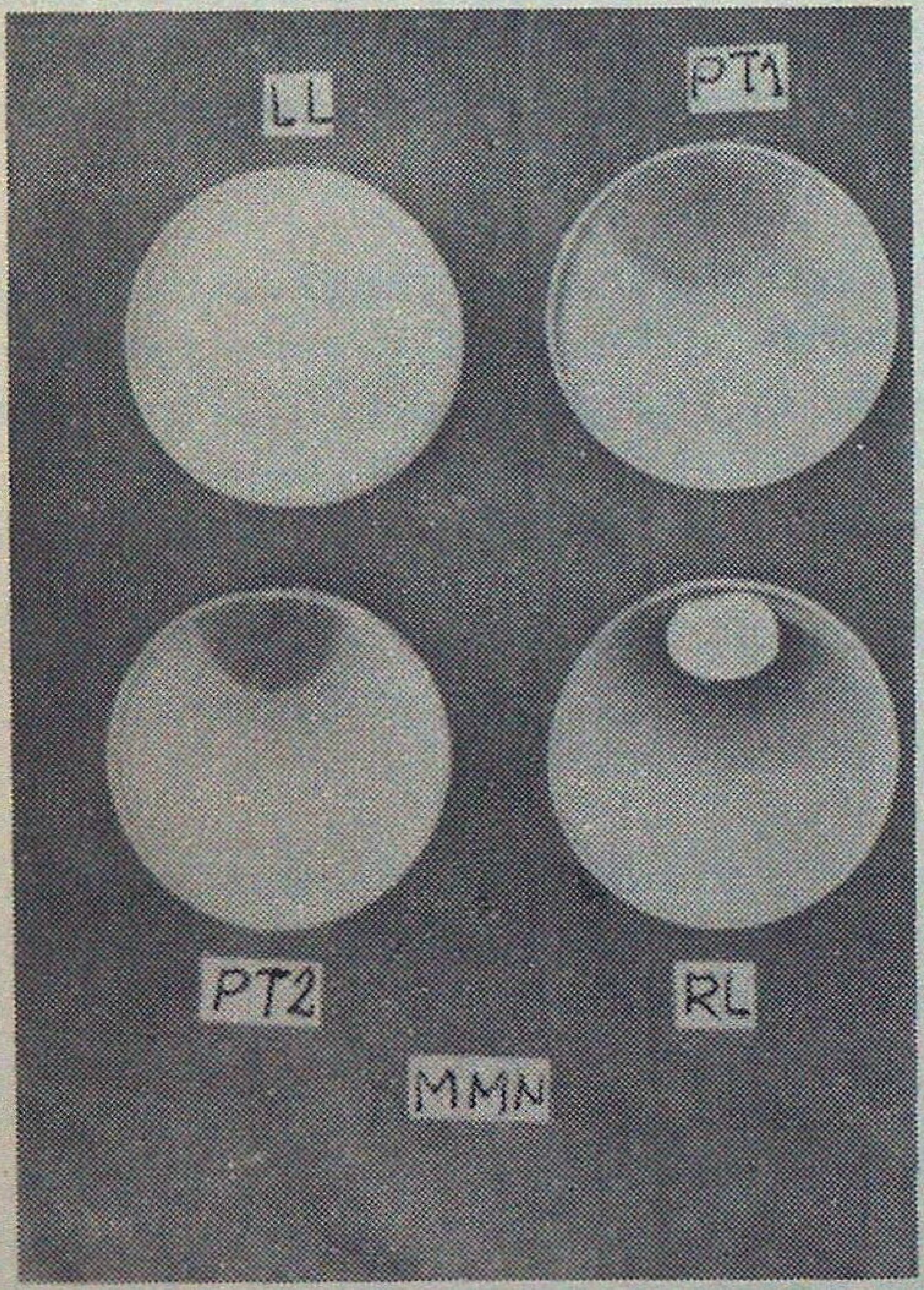
In-vitro studies on the antagonism between ectomycorrhizal fungi and P. aphanidermatum :

(a) *Dual cultural technique* (Dennis and Webster, 1971) : A mycelial disc of 9 mm diameter of mycorrhizal fungi was taken from a vigorously growing colony and placed at one end of a Petri dish containing 15 ml of MMN medium. *P. tinctorius* and *R. leuteolus* were incubated at 27°C in darkness for eight days since they were slow growing while *L. laccata* was grown for four days. Then mycelial disc of 9 mm diam. of the pathogen was introduced at the other end of the Petri dish using sterile cork borer. Treatments were replicated four times. Zone of inhibition was measured on second day from the date of start of the experiment.

(b) *Poisoned food technique* (Grover and Moore, 1962) : *R. leuteolus* which gave highest inhibition zone was further tested for its efficacy at different concentrations by this method. This fungus was grown in MMN solution for 5 days in darkness at room temperature. Mycelial mat was removed by filtration and the culture filtrate was mixed with MMN medium to get 50, 25 and 10 per cent concentrations of culture filtrate in the Petri dish. A mycelial disc of 9 mm diam. of the pathogens was placed at the centre of the agar medium. Each treatment was replicated five times. Observations for the mycelial growth was measured till the control plate was completely covered by the mycelial growth.

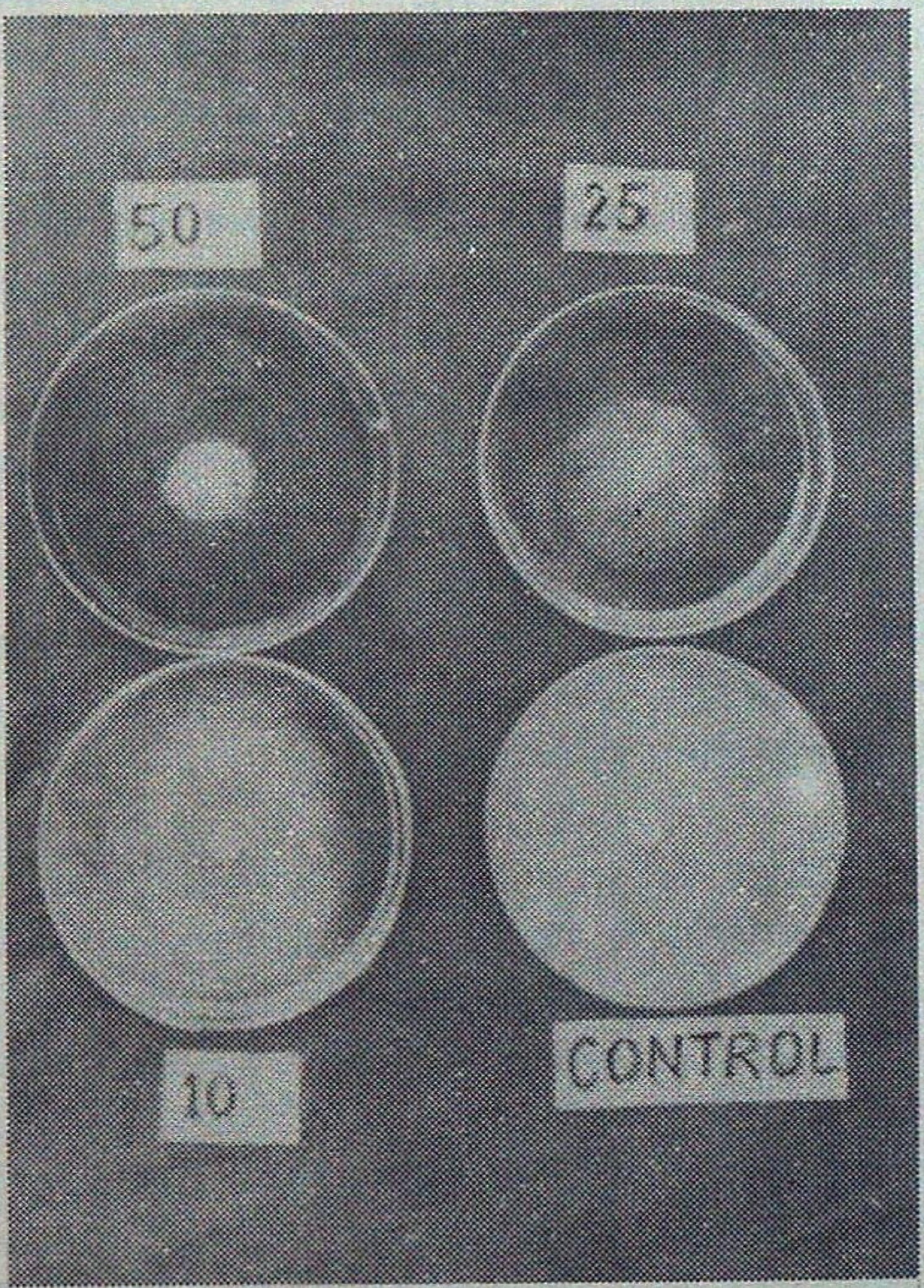
In-vivo studies : Two ectomycorrhizal fungi viz. *R. leuteolus* and *P. tinctorius* isolate-2 were selected for pot culture studies based on *in-vitro* studies. The first experiment had the following treatments. (i) *P. tinctorius*

Fig. 1



Effect of ECTMF on the mycelial growth of *P. aphanidermatum*

Fig. 2



Effect of culture filtrate of *R. leuteolus* on the mycelial growth of *P. aphanidermatum* isolate-2 soil application; (ii) *R. leuteolus* soil application and (iii) metalaxyl soil application. The pathogen was multiplied in sand maize medium for four days when it had completely grown over the surface of the medium. It was mixed with sterilized soil at the rate of 5 g/100g soil. Ectomycorrhizal fungi were grown in MMN medium for 21 days in darkness at room temperature. Five mycelial discs of 5 cm diameter each was mixed thoroughly with the top 10 cm soil in the pot immediately after addition of pathogen. Thirty surface sterilized seeds of *E. tereticornis* were sown in each pot containing 500 g soil and watered daily. Soil drenching with metalaxyl at 0.2 per cent was done immediately after the addition of pathogen. The treatments were replicated six times. Control pots were inoculated with pathogen alone.

The second experiment had the following treatments. (i) *P. tinctorius* isolate-2 seed treatment; (ii) *R. leuteolus* seed treatment and (iii) metalaxyl seed treatment. Seeds were mixed with mycelial mat of 21 day old culture grown in MMN medium so that the fungal mycelium fully covered the seed coat. Metalaxyl at 1 g/kg was given as dry seed dressing.

Observations were recorded on germination and post emergence damping off at 4, 8 and 12 days after emergence. After 12 days, when they had passed the susceptible stage, the surviving seedlings were thinned down to retain 4 plants/pot. Growth parameters and per cent colonisation were recorded 90 days after sowing. Mycorrhizal colonisation of the root system was assessed visually and the estimation of ectomycorrhizae was expressed as a per cent of the total number of short roots/seedling. Ectomycorrhizae were selected from these samples, sectioned and examined to verify Hartig net and mantle formation (Richards and Wilson, 1963).

Results

In-vitro studies :

(a) *Inhibition in dual plates* : Maximum inhibition zone (35 mm) was produced by *R. leuteolus. P. tinctorius* isolate-2 was next in efficacy with an inhibition zone of 18 mm. It was interesting to not that a vast difference in effectiveness between two isolates of same fungus with isolate 1 producing just 5 mm inhibition zone (Fig 1; Table 1).

(b) *Poisoned food technique* : Having observed the high inhibiting activity of *R. leuteolus* the effectiveness of various concentrations of its culture filtrate was tested. Fifty per cent concentration of the cultural filtrate was tested. Fifty per cent concentration of the culture filtrate was highly inhibitory with mere 20 mm growth of the pathogen. In the control plate, by this time, *Pythium* had covered the entire Petri plate. Even 10 per cent concentration inhibited the growth by 32.3 per cent (Fig. 2; Table 2)

In-vivo studies :

Both ectomycorrhizal fungi significantly reduced pre-emergence damping off by seed or soil application by 46.6 to 55.6 per cent and were on par with the fungicide metalaxyl (Table 3). However post emergence damping off was minimum in metalaxyl treatment which was followed by *R. leuteolus*. When the total number of dead seedlings is taken into account, minimum mortality was noticed in metalaxyl treatment. *R. leuteolus* both as seed and soil application was next in efficacy and reduced the disease to 48.3 from 53.3 per cent as against 80.7 per cent in control.

P. tinctorius seed treatment gave maximum increase in biomass over control (29.3 per cent) (Table 3). *R. leuteolus* increased biomass by 15.1 per cent over control. But metalaxyl did not significantly increase the total biomass over control. The per cent colonisation by both ectomycorrhizal fungi ranged from 27.2-33.0 per cent.

Table 1

Inhibitory effect of ectomycorrhizae on P. aphanidermatum in-vitro

Treatment	Growth (mm) after hours								Inhibition zone
	18		24		30		36		
	Pythium	ECTMF	*Pythium*	ECTMF	*Pythium*	ECTMF	*Pythium*	ECTMF	
Pythium + laccata	35	43	36	46	36	48	36	51	3
Pythium + P. tinctorius Isolate 1	34	22	55	23	60	23	61	24	5
Pythium + P. tinctorius Isolate 2	34	16	53	17	53	19	54	18	18
Pythium + R. leuteolus	33	18	34	19	35	19	35	20	35
Pythium alone	34		55		72		90		

Table 2

Effect of R. leuteolus culture filtrate on the growth of P. aphanidermatum in-vitro

Concentration (%)	Growth (mm) after hours					
	6	12	18	24	30	36
10	5	9	19	33	48	68
25	2	5	9	15	25	38
50	2	4	7	10	14	20
Control	9	18	36	57	80	90

Table 3

Effect of ectomycorrhizae on the damping off and growth of E. tereticornis

Treatment	Seedling emergence out of 30 seeds	Post emergence damping off	Surviving seedlings out of 30 seeds	Total biomass (mg)	Infection (%)
P. tinctorius isolate - 2 seed treatment	25.2^{a}	12.8^{c}	12.4^{c}	557^{a}	33.0^{a}
P. tinctorius isolate - 2 soil application	25.0^{a}	14.7^{d}	10.3^{d}	502^{b}	27.5^{bc}
R. leuteolus - seed treatment	25.8^{a}	11.8^{bc}	14.0^{b}	496^{bc}	30.7^{ab}
R. leuteolus - soil application	25.8^{a}	10.3^{b}	15.5^{b}	474^{c}	27.2^{c}
Metalaxyl - seed treatment	26.3^{a}	4.5^{a}	21.8^{a}	432^{d}	0.0^{d}
Metalaxyl - soil application	26.2^{a}	3.0^{a}	23.2^{a}	434^{d}	0.0^{d}
Control (*Pythium* alone)	20.8^{b}	15.0^{d}	5.8^{e}	431^{d}	0.0^{d}

Note : In each column, values followed by a common letter indicates they were on par at (P=0.05)

Discussion

Zak (1971) reported that *Rhizopogon vinicolor* Smith inhibited *Pythium* spp, while Chakravarty and Unestam (1987) reported the inhibitory effect of *P. tinctorius* against *Pythium aphanidermatum*. However, this is the first report on the inhibitory activity of *R. leuteolus* and *P. tinctorius* to *P. aphanidermatum*. The present investigation revealed that one of the isolates of *P. tinctorius* (No. 2) was highly antagonistic to the pathogen while isolate 1 was least effective. The variation in virulence of biocontrol fungi is already established in *Trichoderma* (Papavizas and Lewis, 1981).

Experiment on cell free culture filtrate of *R. leuteolus* indicated that culture filtrate at 50 per cent concentration inhibited mycelial growth to an extent of 77.8 per cent. Kope and Fortin (1989) reported that cell free culture filtrate of *Tricholoma pessundatum* (Fr.) Quel. produced an inhibition zone of 4.7 mm against this pathogen. Concerted effort to purify and identify the antibiotic produced by *R. leuteolus* is a necessary preliminary step in the large scale production of this antibiotic.

The pre-emergence damping off is reduced by ectomycorrhizae to a level equal to that of the fungicide metalaxyl. This indicates that the actively growing mycelium used for seed treatment and soil inoculum secreted an antibiotic which was able to protect the seedlings from pre-emergence damping off. Similar findings of plant protection have been reported in pines by the inoculation of *Lactarius* sp. (Park, 1970).

R. leuteolus and *P. tinctorius* have been shown to be effective symbiont under a wide range of soil conditions (Marx *et al.*, 1977). In addition to these benefits results from the present investigation testify to their additional role of affording protection to roots from deadly pathogens.

Acknowledgements

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SUMMARY

***In-vitro* studies indicated that *Rhizopogon leuteolus* and *Pisolithus tinctorius* isolate-2 were highly antagonistic to the mycelial growth of *Pythium aphanidermatum*, the causal organism for the damping off of *Eucalyptus tereticornis*. *R. leuteolus* significantly reduced damping off in pot culture. *P. tinctorius* and *R. leuteolus* increased the biomass by 29.3 and 15.1 per cent respectively over control.**

बाह्य कवकमूलता उपयोग में लाकर युकेलिप्टस टेरेटिकार्निस स्मि० के आद्रमरण का जैव नियन्त्रण

एम० नारायण भट्ट्, आर० जयराजन व बी० रामराज

सारांश

कांच में किए गए अध्ययनों से पता चला है कि राइजोपोगोन *लायटिओलस* और *पिसोलिथस टिंक्टोरियस* पृथकृत-2 *पायथियम एफानिडमेंटम* का अत्यधिक विरोधी है जो *युकेलिप्टस टेरेटिकार्निस* के आद्रमरण का कारण भूत जीवाणु है । गमला संवर्धन में *रा० लायटिओलस* ने आर्दमरण में काफी कमी ला दी । *पि० टिंक्टोरियस* और *रा० लायटिओलस* ने नियामक की तूलना में जैवपुज में क्रमशः 29.3 और 15.1% की वृद्धि की ।

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EFFICIENT PLANT REGENERATION FROM SEEDS AND NODAL SEGMENTS OF *DENDROCALAMUS STRICTUS* USING *IN-VITRO* TECHNIQUE

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Introduction

Bamboo, a monocotyledonous plant of the family Poaceae, is an important forest tree with multifarious use in daily life (Varmah and Pant, 1981) having largest use in the paper and pulp industry. The country's requirement of paper and pulp may rise to 4.5 million tonnes by the turn of the century (Varmah and Bahadur, 1980). The large scale use of bamboo in paper and pulp industry has led to a situation where replacements and raising of new stands has fallen away behind the rate at which the bamboo culms are being cut (Rao *et al.*, 1988). Bamboos are propagated through seeds, offsets, culm, cuttings and macro proliferation (Kumar *at al.*, 1988). But utilization of seeds as propagating material become difficult and unreliable due to the long and unpredictable flowering habit, low viability and their inborn microbial infestation. Vegetative propagation by offsets and culm cutting are also not efficient on economic scale. To cope with the increasing need for propagating material, the use of *in-vitro* technique is being widely followed for producing large number of propagating materials in different tree and crop plants within a limited time and space. In micro-propagation method, there is little or on chance of deviation to different cytotypes from the elite genotypes which may occur in callus cultures due to the somaclonal variation (Larkin and Scowcroft, 1981). So, by successful micro-propatation, elite bamboo species could be multiplied according to the commercial need. *Dendrocalamus strictus* with its wide adaptability and acceptability has featured in our present study to standardize the *in-vitro* protocol for a continuous supply of propagating material from the seeds as well as from the nodal segments of *in-vitro* grown plantlets.

Materials and Methods

Seeds of *Dendrocalamus strictus* were collected from forests of Midnapore District of West Bengal and were kept in dessicator at 25 + 2 °C for about 9 months for further *in-vitro* studies on viability of the seeds. The chemicals used for *in-vitro* cultivation were of analytical grade (Sigma, E Merk and Glindia) and glassware are of Borosil^R grade.

For exenic germination of seeds, germinating media was prepared with basal nutrients of MS (Murashighe and Skoog, 1962) and it was further supplemented with two kinds of phytohormones to overcome the poor germinability of old seeds. Two types of germinating media, liquid and solid, supplemented with different hormones were used. The liquid medium was placed on rotary shaker with 120 rpm. The seeds were first washed with 1% Cetavlon (Centrimede solution, ICI) for one minute and then rinsed thoroughly under running tap water. Washed thrice with sterilized distilled water under laminar air flow cabinet. Seeds were again treated with rectified spirit for 30 seconds and washed thrice with sterilized distilled water and were again treated with rectified distilled water and were then inoculated into the culture media. The germinating flask containing the seeds were kept under total dark condition at 25 + 2°C.

The germinating seeds were then transferred to culture madia for further growth and development of multiple shootlets. Culture media were prepared with MS basal nutrient supplemented with three phytohormones i.e. 2, 4-D, BAP and GA. Nodal segments were separated from 60 days old *in-vitro* plantlets and cultured on specific medium for organogenetic studies. The cultures were kept under 16/18 h photoperiod with 1500 lux light intensity.

Results and Discussion

The data recorded for the three phase experiment were analysed statistically and are presented in Tables 1, 2 and 3. The seeds of bamboo species have very low viability in general. To improve the viability and germinability, seeds were cultured on both liquid and solid media with six levels of and BAP and GA for each of the treatment (Table 1). It was observed that BAP at comparatively lower level i.e. 0.5 mg/l to 1.5 mg/l had increased the germinability over 15% but the germination percentage

Table 1

Percentage of seeds germinated on liquid and semisolid media along with different levels of BAP and GA.

Growth regulator (mg/l)	Seeds germinated on liquid medium	Seeds germinated on semisolid medium
BAP 0.5	22.87 + 0.85	6.78 + 0.42
BAP 1.0	33.15 + 0.43	9.26 + 0.37
BAP 0.5	18.45 + 0.33	7.85 + 0.36
BAP 2.0	14.23 + 0.41	3.25 + 0.41
BAP 2.5	8.03 + 0.31	3.65 + 0.38
BAP 3.0	3.05 + 0.32	2.26 + 0.31
Control	11.03 + 0.27	6.87 + 0.29
GA 0.5	79.27 + 1.12	26.63 + 0.41
GA 1.0	82.56 + 0.87	37.26 + 0.65
GA 1.5	76.23 + 0.56	41.63 + 0.56
GA 2.0	67.69 + 0.48	22,78 + 0.52
GA 2.5	42.63 + 0.78	17.65 + 0.26
GA 3.0	40.05 + 0.63	17.20 + 0.31

Table 2

Mean number of shoots / corm on MS medium with different levels of growth regulators

Growth regulators (mg/l)		Mean shoots/corm
BAP	0.5	8.16 + 0.16
	1.0	8.66 + 0.47
	1.5	9.95 + 0.82
	2.0	13.23 + 0.45
	2.5	7.76 + 0.17
	3.0	2.93 + 0.30
Control		nil
2, 4-D	0.5	2.92 + 0.20
	1.0	3.90 + 0.16
	1.5	2.00 + 0.17
	2.0	0.00 + 0.00
	2.5	0.00 + 0.00
	3.0	0.00 + 0.00
GA	0.5	15.23 + 0.30
	1.0	21.26 + 0.40
	1.5	16.56 + 0.58
	2.0	7.90 + 0.32
	2.5	1.76 + 0.22
	3.0	1.40 + 0.11

Table 3

Percentage of responsive nodal segments and days to bud break in culture

Kinetin (mg/l)	BAP mg/l	Responsive nodal	Days to bud
0.2	1.0	35.11 + 0.78	37.00 + 0.94
0.2	2.0	43.50 + 0.38	30.66 + 0.72
0.2	3.0	23.17 + 0.63	41.66 + 0.54
0.2	4.0	8.59 + 0.35	56.33 + 1.18
0.5	1.0	64.18 + 0.86	29.66 + 0.98
0.5	2.0	72.64 + 0.76	26.33 + 0.72
0.5	3.0	14.25 + 0.52	59.33 + 0.72
0.5	4.0	6.28 + 0.41	60.66 + 1.51

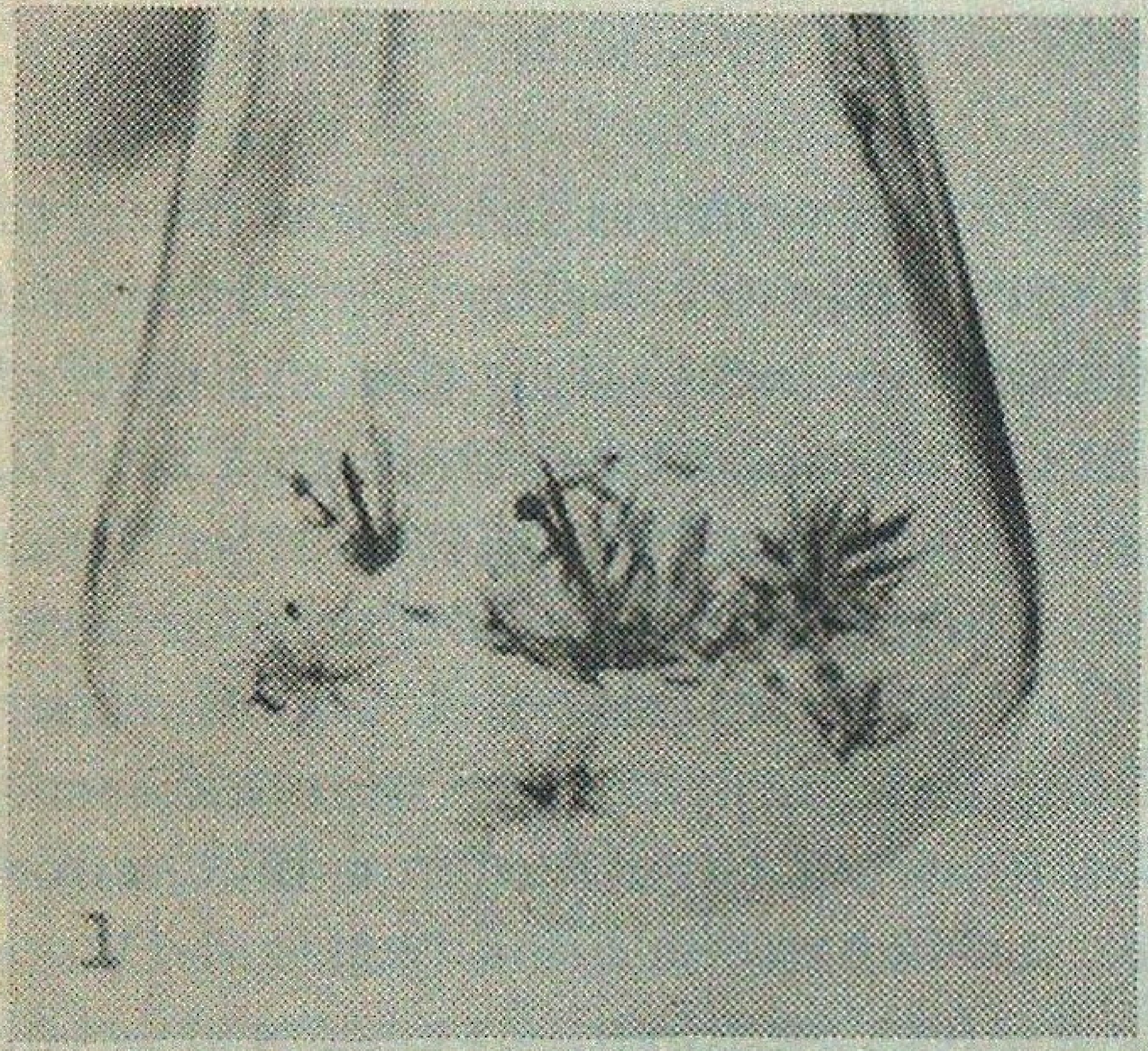
decreased considerably at higher BAP level. Comparing with the effects of BAP, GA at a concentration of 0.5 to 2.0 mg/l was found to be more potent to increase the percentage of germination (Fig. 1) and maximum percentage was recorded at a concentration of 1.0 mg/l. The results further showed that at higher concentration of GA (2.5 and 3.0 mg/l) the germination was somewhat lower but still it was greater than that of different levels of BAP. Comparing the effect of solid medium on germination of incubated seeds, the liquid medium following the agitation in rotary shaker was found to increase the germination. Mascarenhas *et al.* (1988) have found similar result in bamboo. The agitation may increase the rate of nutrient and hormonal uptake which thereby increased the percentage of germination. Bamboo seedlings possess inherent capacity to proliferate (Kumar *et al.*, 1991). To increase the number of shootlets from germinating seeds, they were further transfered to solidified media supplemented with tree types of phytohormones (viz. BAP, 2, 4-D and GA) at six different levels of concentrations (0.5 to 3.0 mg/l). Mean number of shootlets from a seed was below 10 per cent at five levels of BAP concentrations (Table 2). Only at concentration of BAP (2 mg/l) the mean number of shootlets was higher than 10 per cent (13.48%) but at comparatively higher concentration the mean number was reduced.

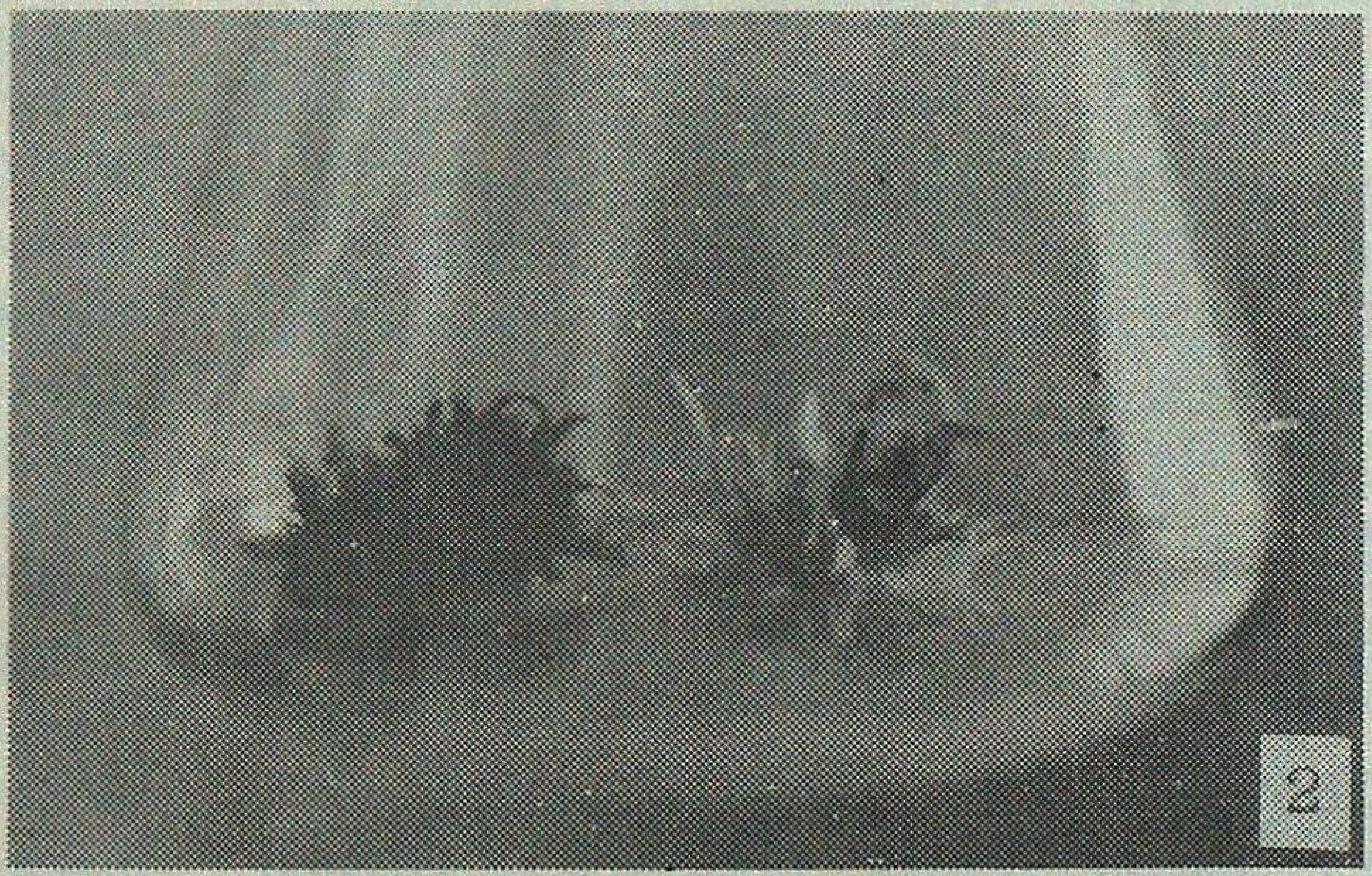
The phytohormone 2, 4-D was found to have a very little or no effect in improving the efficacy on increasing the number of shootlets. At lower concentration of 2, 4-D, the mean number of shootlets varied from 2-4 (0.5 - 1.5 mg/l) and at more higher level (2.0 - 3.0 mg/l) no shootlet was further produced from the already germinated seeds and the growing corm became blackened (Fig. 2). It can be concluded that 2, 4-D has negative effect on shootlet regeneration or have no effect on regeneration and lower number of shootlets at low concentration was the effect of nutrient medium and other cultural conditions.

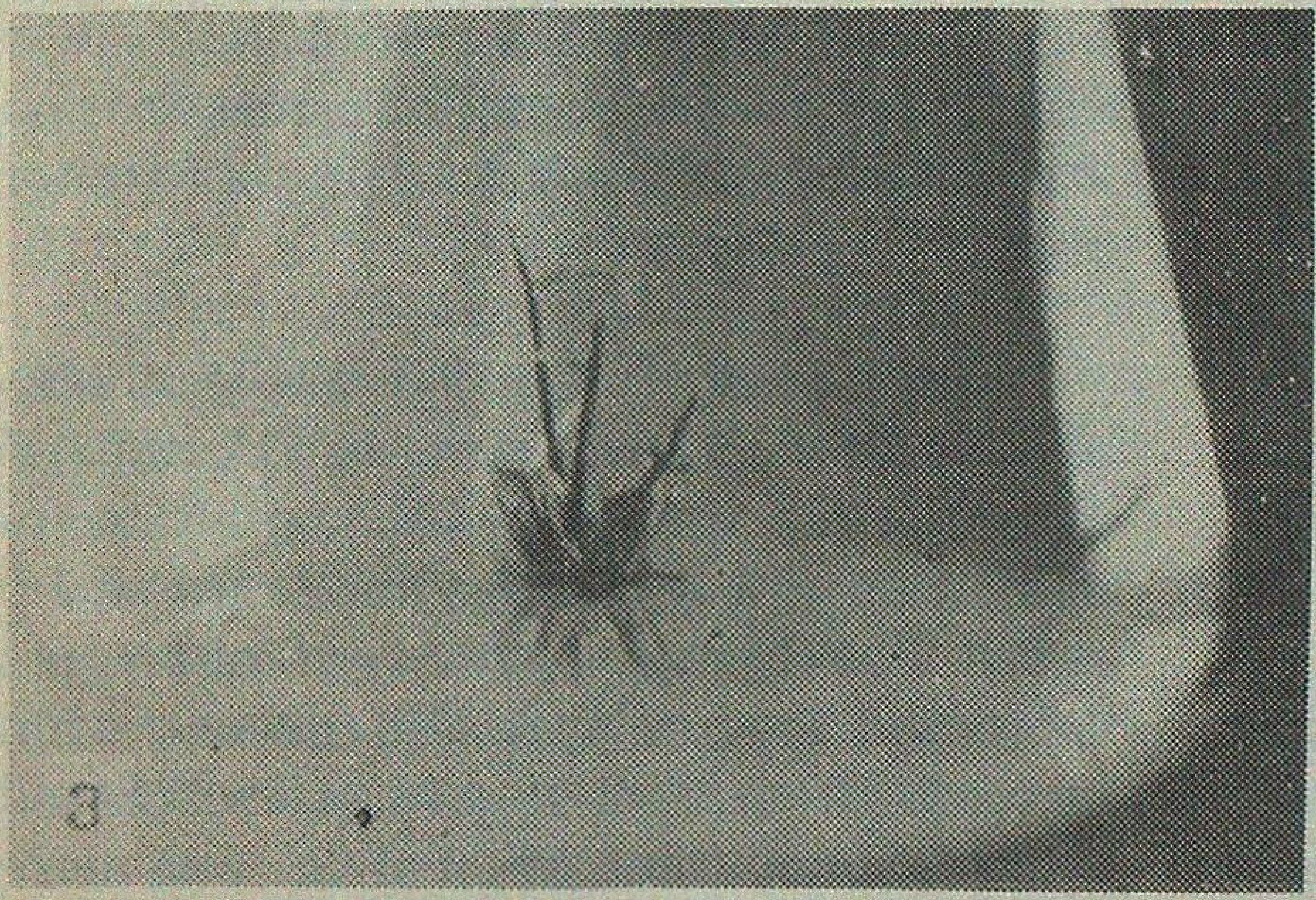
The results from the Table 2 also showed that at lower level of GA (0.5-1.5 mg/l) the mean number of shootlets were more than 15% and it was maximum at 1.0 mg/l. The Mean number of shootlets decreased gradually as GA concentration increased from 2.0-3.0 mg/l and it was found that higher concentration of GA was more deleterious than higher concentration of BAP. From the result it can be concluded that GA at lower concentration has a significant shootlet regeneration potentiality but higher concentration became toxic to usual shootlet development.

For organogenetic study from nodal segments MS medium with different combinations of Kinetin and BAP were used. From the experiment, percentage of responsive nodal segments and respective days to bud break were calculated (Table 3).

Fig. 1-4







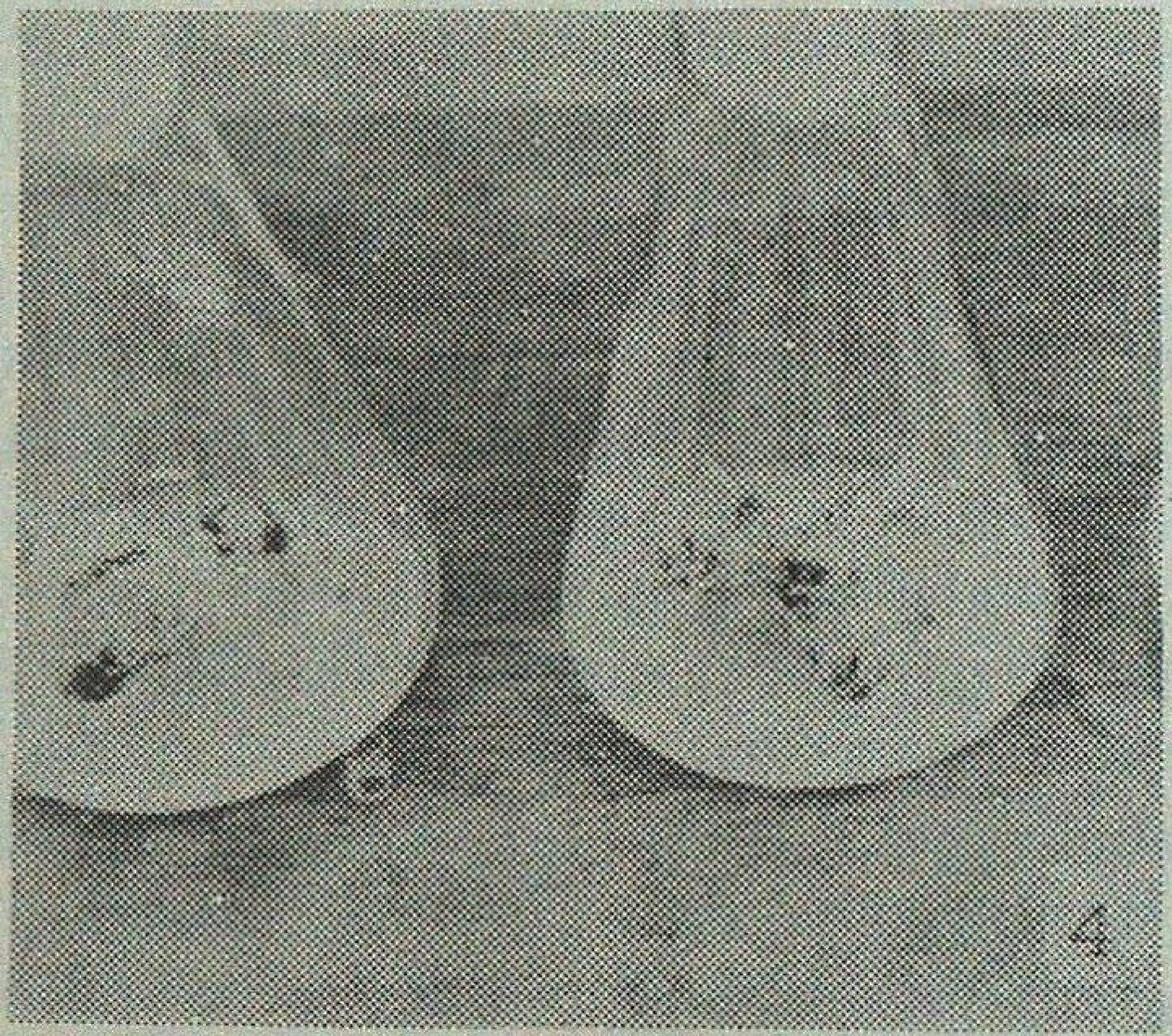


Fig. 1 : Profuse germination of old seeds on MS medium supplemented with GA.
Fig. 2 : Blackened corm on medium supplemented with high 2, 4-D.
Fig. 3 : Decreased bud break of nodal segments with high BAP.
Fig. 4 : Higher organogenesis from nodal segment with 0.5 mg/l Kinetin and 2 mg/l BAP.

It was observed that at low level of Kinetin and comparatively higher level of BAP (0.2 against 1.0 and 2.0 mg BAP) the percentage of responsive nodal segments varied from 35-45% but at more increased concentration of BAP (3.0 and 4.0 mg/l) supplemented with constant level of Kinetin (0.2 mg/l), the percentage of organogenic segments (Fig. 3) was decreased. At somewhat higher level of Kinetin (0.5 mg/l) and BAP (1.0 and 2.0 mg/l) the percentage of responsive segments was more than 50% (Fig. 4) and the response was maximum (72.64%) at 0.5 mg/l kinetin along with 2.0 mg/l BAP. But the higher concentration of BAP (3.0 and 4.0 mg/l) with Kinetin (0.5 mg/l) lowered the percentage of bud break abruptly. Regarding days to bud break it has been observed that higher percentage of bud break (responsive organogenetic nodal segments) associated with lesser days to bud break and maximum days to bud break took place with lowest frequency of percentage of responsive nodal segments. From Table 3 it can concluded that early bud break helps to regenerate more shootlets from the nodal segments.

The study clearly establishes the potentiality of GA in seed germination as well as clump formation from those germination seedling. The cytokin BAP showed its role in organogenesis at lower concetaration but the higher concentration was deletarious for the purpose. The experiment also showed that lower days to bud break was associated with higher percentage of responsive nodal segments.

SUMMARY

Bamboo is an important monocotyledonous plant with multifaceted use. But mass scale exploitation of this natural resource is sometimes limited owing to non-availability of seeds due to irregular flowering habit and insufficient supply of planting materials conventionally produced through culm cuttings. This papers describes the methods of continuous supply of propagating materials through *in-vitro* culture of *Dendrocalamus* sp. Methods have been standardized for efficient germination of old seeds and regeneration of shoot buds from nodal segments of *in-vitro* plantlets. GA at concentrations 0.5-2.0 mg/l was most effective in increasing germination, but BAP at 2.0 mg/l showed higher percentage of shootlet formation from the nodal segments. The effect of other cytokinins on bud break and subsequent development were also discussed.

काँच प्रविधि उपयोग में लाकर डेण्ड्रोकैलेमस *स्ट्रिक्टस* के बीजों और ग्रंथा खण्डों से सुदक्ष पादप पुनर्जनन कराना

सुब्रता मायति व अंजन घोष

सारांश

बांस महत्वपूर्ण एकबीजपत्रीय पादप है जिसे कई प्रकार से उपयोग किया जाता है । इसके पुष्पन की अनियमी प्रवृति के कारण बीज न मिल पाने और संधिस्तम्भों की कलमों द्वारा पारम्परिक तरिके से रोपण सामग्री पर्याप्त न मिल पाने से कभी-कभी इस प्राकृतिक संसाधन का वृहत परिमाण पर समउपयोजन करना सीमित ही रहता है । इस अभिपत्र में डेण्ड्रोकैलेमस की जाति का कांच संवर्धन करके प्रवर्धन सामग्री के निरन्तर मिलते रहने की विधि का वर्णन दिया गया है । पुराने बीजों का सुदक्ष पुनर्जनन और कांच में तैयार किए गए छोटे पौंधे के ग्रन्था खण्डों प्ररोह कलिकाएँ पुनर्जनित कराने की विधि प्रतिमानित की जा चुकी है । अंकुरण कराने के लिए जिबेरेलिक अम्ल 0.5 - 2.0 मिग्रा/ लि० अंकुरण बढ़ाने में सर्वाधिक प्रभावकारी रहा परन्तु अधिक प्रतिशत में जडें निकलवाने में 2.0 मिग्रा / लि० बीएपी लेना ग्रन्था खण्डों में छोटी जडें निकलवाने वाला पाया गया । कली फुटने, उसके बाद के विकास पर अन्य कोषाकिनिनो का प्रभाव भी विवेचित किया गया है ।

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Snippets GIS

Planex is a timber-harvesting program that uses GIS (Geographic Information System) data and mathematical model to solve problems such as where to locate harvesting equipment and logging roads. GIS provides information about the topography of the area to be harvested, the volume of standing timber, and existings roads. Two engineers from the University of Chile developed the program to include an interactive graphic interface; the user sees the real situation on the computer and can try out options for modifying it. Options include entering basic data (such as road-building costs), or technical parameters (such as maximum slopes for trucks and skidders). The program finds a solution that allows harvesting all the timber that can be taken profitably, while minimizing operation and road costs. The program shows where to put equipment, where to build the roads, and how much timber to remove from each sector. Running on a 486 PC and using 16 MB RAM, Planex can generate solutions for a 400-ha area in 10 to 15 minutes; modifications may take 3 to 5 minutes to analyze.

Source: *LIGNUM-Chile, 1995.*

SUSCEPTIBILITY LEVEL OF FEW PLANTS ON BASIS OF AIR POLLUTION TOLERANCE INDEX

S. AGRAWAL * AND S.L. TIWARI **

Introduction

During the past many decades, there has been a growing awareness about the serious hazards of atmospheric pollution to which we are constantly exposed. The damaging effect of air pollutants on vegetation have been recognised (Dasgupta, 1957; Treshow, 1984). Hence it should be primarily taken into consideration control must be effected at the sources of emission, because once pollutant is emitted in, it cannot be checked from wide distribution. A new approach to grow green plants in and around industrial complex has been evolved.

Different plant species vary considerably in their susceptibility to air pollutants. Screening of plants for their sensitivity to air pollutants is of vital importance. Capacity of plants to reduce air pollution is very well known (Tingey, 1968; Bannett and Hill, 1973) to check the spread of such air pollutants emitted from an industrial complex, it is recommended to grow a green vegetation around by many scientists (Fleming, 1967; Warren, 1973; Agrawal *et al.*, 1988, 1989; Tiwari, 1991).

In present study, the susceptibility levels of different plants growing in industrial Patrapali region of Raigarh District has been evaluated on the basis of their Air Pollution Tolerance Index.

Materials and Methods

Patrapali, were iron and steel industry is located is situated 11 km away from Raigarh District Madhya Pradesh at 21^0 53' N latitude and 83^0 - 23' E longitude at an elevation of 220 m from the mean sea level. The dust emitted by iron and steel industry is a mixture of Aluminum, Calcium, Silica, Iron, Magnesium and Sulphur oxide.

The study was conducted in December 1995 and January 96 for estimation of Air Pollution Tolerance Index (APTI). Leaves from top, middle, and base canopy of plants were collected in the forenoon between 07.00 and 08.00 hours. A care was taken for plants going under investigation should have iso-ecological condition with respect to light, water, soil and pollutant exposure. The collected samples were analysed for ascorbic acid, leaf extract, pH, total chlorophyll and relative water content. The control was taken 15 km away from the Industry in prevailing wind direction.

The ascorbic acid content mg g^{-1} dry wt was estimated by the method of Keller and Schwanger (1977). Total chlorophyll mg g^{-1} dry wt. was estimated following MacLachlon and Zalik (1963). Relative water content was determined following Weatherly (1965). Leaf extract pH was measured with a digital pH meter.

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The air pollution tolerance index was determined by following the formula proposed by Singh and Rao (1983).

$$\text{APTI} = \frac{A(T+P)+R}{10}$$

Where

A = Ascorbic acid content of leaf $mg.g^{-1}$ dry. wt.

T = Total chlorophyll of leaf in $mg.g^{-1}$ dry wt.

P = Leaf extract pH.

R = Per cent relative water content of leaf.

The total sum is divided by 10 to get a manageable value.

Results and Discussion

As shown in Table 1, the ascorbic acid content was maximum for plant *Albizia lebbek*, 13.28 mg g^{-1} dry wt. and minimum 0.43 mg. g^{-1} dry wt. for *Pongamia pinnata*.

Ascorbic acid being a strong reductant protects chloroplasts against SO_2 induced H_2O_2 O_2^- and OH accumulation and thus protects the enzymes of the CO_2 fixation cycle and chlorophyll from Inactivation (Tanaka *et al.*, 1982). Together with leaf pH, it plays a significant role in determining the SO_2 sensitivity of plants (Chaudhary and Rao, 1977). Thus plants maintaining high ascorbic acid level under polluted

Table 1

Air Pollution Tolerance Index of few tree species in their decreasing order

Species.	T	P	A	R	APTI
Albizia lebbek	3.35	6.7	13.28	57.10	19.0
Ficus gibbosa	3.26	7.6	3.82	75.51	11.7
Terminalia arjuna	3.16	5.7	4.62	71.51	11.2
Madhuca latifolia	3.20	6.0	3.70	77.61	11.1
Pithecalobium dulce	4.54	5.9	3.81	68.03	10.7
Acacia catechu	1.71	6.4	3.38	77.18	10.4
Terminalia tomentosa	2.13	5.7	4.93	66.00	10.4
Eucalyptus globulus	2.68	5.6	4.06	73.88	10.4
Adina cordifolia	2.54	4.5	3.88	72.62	9.9
Litchi chinensis	4.13	6.2	2.26	74.94	9.8
Azadirachta indica	3.48	6.5	2.53	70.44	9.61
Syzygium cumini	3.02	5.9	1.32	82.56	9.43
Carica carandus	3.32	6.5	1.34	82.64	9.4
Ficus religiosa	4.65	7.4	2.98	57.56	9.34
Bombax malabarica	0.65	6.3	0.84	85.28	9.1
Citrus aurantifolia	1.89	6.1	2.0	74.21	9.0
Gmelina arborea	2.11	6.4	3.77	58.49	9.0
Diospyros melanoxylon	1.70	4.8	3.92	64.40	8.9
Citrus reticulata	2.76	5.0	2.0	67.3	8.4
Pongamia pinnata	4.90	6.2	0.43	75.76	8.05
Tectona grandis	0.91	6.5	3.23	47.44	7.1
Annona squamosa	4.37	6.0	2.48	34.64	7.07
Hibiscus rosasinensis	4.23	6.4	2.67	41.11	6.94
Aegle mormelos	4.48	7.1	2.56	27.68	5.73

T = Total chlorophyll in $mg.g^{-1}$ dry wt.

A = Ascorbic acid in mg g^{-1} dry wt.

APTI = Air pollution tolerance index.

P = Leaf extract pH.

R = Per cent relative water content.

condition are considered to be tolerant to air pollutants.

The maximum total chlorophyll was 4.90 mg.g^{-1} dry wt. in *Pongamia pinnata* and minimum 0.65 mg.g^{-1}dry wt. in *Bombax malabarica*. Under pollution stress chlorophyll level decreases (Speadding and Thomas, 1973). Plants appearing green and normal at low concentration of SO_2, show reduced efficiency of photosynthesis (Varshney, 1982). Thus plants having high chlorophyll content under field condition are generally tolerant to air pollutants.

The leaf extract pH was maximum 7.6 in *Ficus gibbosa* and minimum 4.5 in *Adina cordifolia*. Scholz and Reck (1977) have reported that in presence of an acidic pollutant the leaf pH is lowered and the decline is greater in sensitive species. A shift in cell sap pH towards the acid side in presence of an acidic pollutant might decrease the efficiency of conversion of hexose sugar to ascorbic acid. However the reducing activity of ascorbic acid is pH controlled being more at higher and less at lower pH. Hence the leaf extract pH on the higher side give tolerance to plants against pollution (Agrawal, 1988).

The relative water content was maximum 85.25% in *Bombax malabarica* and minimum 27.68% in *Aegle marmelos*. Relative water content is associated with protoplasmic permeability in cells causes loss of water and dissolved nutrients, resulting in early senescence of leaves (Masuch *et al*., 1988). It is likely therefore that plants with high relative water content under polluted conditions may be tolerant to pollutants.

APTI of *Albizia lebbek* was maximum 19.0 and *Aegle marmelos* showed the minimum 5.73 value. Different plant species vary considerable in their susceptibility to air pollution. The plants with high APTI and low APTI can serve as tolerant and sensitive species respectively. The cultivation of such species in polluted habitats leads to rapid amelioration of habitat to cope with polluted environment. Such plants can effectively be used as indicators and pollutant scavengers (Singh and Rao, 1983; Agrawal, 1989, Tiwari, 1991). The results from the study reveals that *Albizia lebbek* can be considered as tolerant and *Aegle marmelos* as sensitive species to air pollution in which the former can serve as sink and latter as indicator to air pollution.

SUMMARY

Trees vary considerably with their susceptibility to Air pollution. Cultivation and conservation of certain trees which are fast growing, resistant and sensitive to certain pollutant can make environment free from pollution to some extent. In present study the susceptibility level of plants to air pollutants, have been evaluated on the basis of their APTI value. For the purpose four parameters namely ascorbic acid, leaf extract pH, relative water content and total chlorophyll were determined and computed in the formula proposed by Singh and Rao (1983) to get APTI. The plants with low APTI value were categorised as sensitive and with high APTI as tolerant because the former can serve as indicator and latter as sink for the abatement of air pollution.

वायु प्रदूषण सह्यता निर्देशांक के आधार पर कतिपय पादपों का सुप्रभव्यता स्तर

एस० अग्रवाल व एस०एल० तिवारी

सारांश

वायु प्रदूषण के प्रति सुप्रभाव्यता में वृक्षों में परस्पर काफी अन्तर पाया जाता है । ऐसे वृक्षों का जो शीव्रवर्धी, कतिपय प्रदूषकों के प्रतिरोधी और उनके प्रति प्रभविष्णु हो, लगाना और उनका संरक्षण करना कुछ सीमा तक पर्यावरण को प्रदूषण मुक्त बना सकता है । वर्तमान अध्ययन में वायु प्रदूषकों के प्रति कुछ पादपों के सुप्रभाव्यता स्तरों का मूल्यांकन उनके वायु प्रदूषण

सह्यता निर्देशांकों के आधार पर किया गया है । इस प्रयोजन के लिए चार परिमाप अर्थात् एस्कोर्बिन अम्ल, पर्ण निस्सार पीएच, आपेक्षिक जल तत्व और कुल पर्णशाद को विनिश्चित किया गया और वायु प्रदूषण सह्यता निद्रेशांक प्राप्त करने के लिए सिंह व राव (1983) द्वारा प्रस्तावित सूत्र के अनुसार संगणित किया गया है । कम वायु प्रदूषण सह्यता निर्देशांक अर्हा वाले पादप प्रभविष्णु (या सुकोमल) श्रेणी में रखे गए और जिनका वायु प्रदूषण सह्यता निर्देशांक अधिक निकला उन्हें सहनकर्ता श्रेणी में रखा गया क्योंकि पहले वाले सूचक की तरह तो बाद वाले वायु प्रदूषण कम करने के लिए डुबान कुण्ड का काम दे सकते हैं ।

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ENDOMYCORRHIZAL ASSOCIATIONS OF ACACIAS IN NURSERIES AND PLANTATIONS OF INDIAN ARID ZONE

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Introduction

The arid zone of Rajasthan has about twenty seven per cent area under wastelands, sand dunes and deserts. These ecosystems are characterized by moisture stress which acts as the major limiting factor for the productivity and regeneration of woody species. Afforestation and reforestation on massive scale have been recognized as the most appropriate approach to improve living conditions in arid regions by stepping up food, fodder, fuel and timber production besides ameliorating soils and environment of the deserts. Among the different methods adopted for afforestation of these areas, application of microorganisms for the establishment of higher plant species is well recognized. Inoculating seedlings with suitable and improved microbial fertilizers including vesicular-arbuscular mycorrhizal (VAM) fungi which are tolerant to extremes of temperature, high soil pH, drought, etc., is one of the important techniques for the rehabilitation of these areas.

The role of sand colonizing plants in controlling sand movement and in stabilizing sand dunes has received more attention after studies of Cowles (1899). Since then, lot of literature has accumulated on sand dune ecology, but the importance and potentiality of VAM fungi in the survival, establishment and growth of sand dune species have been overlooked.

Acacias are important tree species of agro-forestry and silvopastoral systems of Rajasthan. They are preferred for fodder, fuel, gum and timber. Moreover, *Acacia* species act as nitrogen fixer, excellent soil binder and dune stabilizer. Two members of family Mimosaceae, *Acacia nilotica* sub species *indica* (Babul) and *A. tortilis* sub species *raddiana* (Israeli babul) are distributed in northern/central and western parts of Rajasthan, respectively. The former is indigenous to this area while the latter was introduced in India in 1958 from Israel.

A. nilotica sub species *indica* prefers alluvial soil, low to moderate rainfall and considerable amount of soil moisture for its survival and growth. However, it is drought resistant and suitable for marginal land planting. The other species, *A. tortilis* sub species *raddiana* can be grown in wide ranges of soil i.e., from saline to gypseous. The study of mycorrhizal associations of Acacias at nursery and plantation sites are crucial to access their dependence on mycorrhizal fungi as well as selecting out candidate species of endomycorrhizal fungi for mass multiplication. In turn, selected VAM fungi may be used for fortifying the

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desired tree species in nursery before taking them for plantation at harsh sites like arid zone of Rajasthan. The present investigation reflects all these aspects of mycorrhizal technology in its unfolding.

Materials and Methods

Surveys were conducted to collect roots and soil samples of *Acacia* spp. viz., *A. nilotica* sub species *indica* and *A. tortilis* sub species *raddiana* from various nurseries and plantations located in and around Jodhpur District of Rajasthan. The root samples were washed gently and thoroughly in tap water and fixed in FAA (13 ml Formalin + 5 ml Acetic Acid + 200 ml 75% Alcohol) for estimation of root infections. Root segments (each approximately one cm long) were cleared and stained in trypan blue (Phillips and Hayman, 1970) for root colonization and types of VAM association. One hundred root segments in six replicates were examined for each sample. Per cent root colonization was quantified based on the number of root segments colonized by VAM fungi.

VAM fungal spores were isolated and number counted from the rhizosphere soil samples of both nursery and plantation sites (six replicates from each site) by using wet sieving and decanting technique (Gerdemann and Nicolson, 1963). Number of spores present in the soils were calculated in 100 ml of air dried soil. The species level identification of different VAM fungi was done following the keys of Trappe (1982) and Schenck and Perez (1987). The data was anlysed statistically by ANOVA.

Results and Discussion

Surveys undertaken in nurseries and plantations in different locations of Rajasthan for mycorrhizal status, types of VAM association and the taxonomic profile of indigenous and exotic *Acacia* spp. have been discussed in the following paragraphs:

Per cent root colonization and rhizosphere spore populations of Acacia seedlings in nurseries : The per cent colonization in roots and spore populations in rhizosphere soil samples collected from various nursery sites are shown in Table 1. In *A. nilotica*, maximum per cent colonization was observed from the root samples of Osean

Table 1

Per cent root colonization and rhizosphere spore populations of different VAM fungi in Acacia nilotica and A.tortilis seedlings from various nursery sites in Rajasthan

Nursery sites	Root colonization(%)		Soil spore population (spores/100 ml of soil)	
	Acacia nilotica	*Acacia tortilis*	*Acacia nilotica*	*Acacia tortilis*
Jhalamand (AFRI nursery)	32	68	108	221
Lokswell	48	58	161	193
Osean	60	73	234	269
Phalodi	55	75	209	286
Tinwari	51	60	186	201
S.E (m)	3.09	4.15	21.15	20.76
CD at 5% level	7.5	10.1	51.6	50.7

nursery (60%) and minimum in Jhalamand (32%). Rest of the three nurseries have statistically similar range of root infection. Seedings of *A. tortilis* had maximum root infection at Phalodi nursery (75%) which was at par with two other nurseries i.e Osean and Jhalamand. Minimum root infection of 58 per cent was recorded at Lokswell nursery.

Similar findings were observed in soil spore population in the rhizosphere of both *A. nilotica* and *A. tortilis* tree species in various nursery sites. Maximum spore number was seen in the rhizosphere of *A. nilotica* and *A. tortilis* seedlings in Osean (234) and Phalodi (286) nursery sites, respectively and were highly significantly than many other sites. Likewise, minimum

Table 2

Distribution of VAM fungi in the rhizosphere of Acacia nilotica (An) and A. tortilis (At) seedlings of various nursery sites in Rajasthan

VAM fungi	Sampling sites										Site Frequency (%)	
	1		2		3		4		5			
	An	At	An	At	An	At	An	At	An	At	An	At
Glomus aggregatum	+	-	-	-	+	+	+	-	+	+	80	40
G. claroideum	-	+	-	-	+	+	-	+	-	-	20	60
G. fasciculatum	-	+	+	+	+	+	-	+	-	+	40	100
G. microcarpum	-	+	-	-	+	-	+	+	-	-	40	40
G. occultum	-	-	-	+	-	-	+	+	-	-	20	40
Gigaspora sp.	+	-	+	-	-	+	-	-	+	+	60	40

(1) Jhalamand; (2) Lokswell; (3) Osean; (4) Phalodi; (5) Tinwari. (-) = Absent; (+) = Present

Table 3

Per cent root colonization and rhizosphere spore populations of different VAM fungi in Acacia nilotica and A. tortilis plants from various plantation sites in Rajasthan

Plantation sites	Root colonization(%)		Soil spore population (spores/100 ml of soil)	
	Acacia nilotica	*Acacia tortilis*	*Acacia nilotica*	*Acacia tortilis*
Banar	46	72	198	352
Bapupura	53	80	200	370
Chaukha	42	64	176	289
Chopasni	74	68	305	306
Devlia	58	85	212	393
Gudavoisinion	66	72	292	344
Jhalamand	48	55	191	261
Mandore	39	66	147	297
Mogera	60	92	289	406
Osean	59	82	241	366
S.E.(m)	4.69	3.89	19.46	16.76
CD at 5% level	11.2	9.3	46.4	39.9

spores were counted from Jhalamand (108) for *A. nilotica* and from Lokswell (193) for *A. tortilis*.

Frequency distribution of VAM fungi in the rhizosphere of Acacia spp. in nurseries : The soil surrounding the root zone of *Acacia nilotica* and *A.tortilis* were screened for the isolation and identification of different VAM spores in view to find out their frequency distribution (Table 2). It was observed that almost all the soil samples contained spores of different species of the genera *Glomus* and *Gigaspora*. A total of six different species of VAM fungi were identified. Of which, *Glomus aggregatum* was the most frequently found (80%) followed by *Gigaspora* sp. (60%) from the rhizosphere of *A. nilotica* seedlings and *Glomus fasciculatum* was the most frequently observed (100%) followed by *G. claroideum* (60%) from the root zone of *A. tortilis*.

Per cent Root colonization and rhizosphere spore populations of Acavia spp. in plantations : The root samples of both the tree species showed mycorrhizal associations. The levels of mycorrhizal colonization varied from one site to the other. Vesicular and arbuscular structures were very common in the roots of both nursery and plantation samples. Vesicles, mostly globose to sub-globose in shape, were very common in the roots of both the tree species in different plantation sites (Fig. 1 a-b).

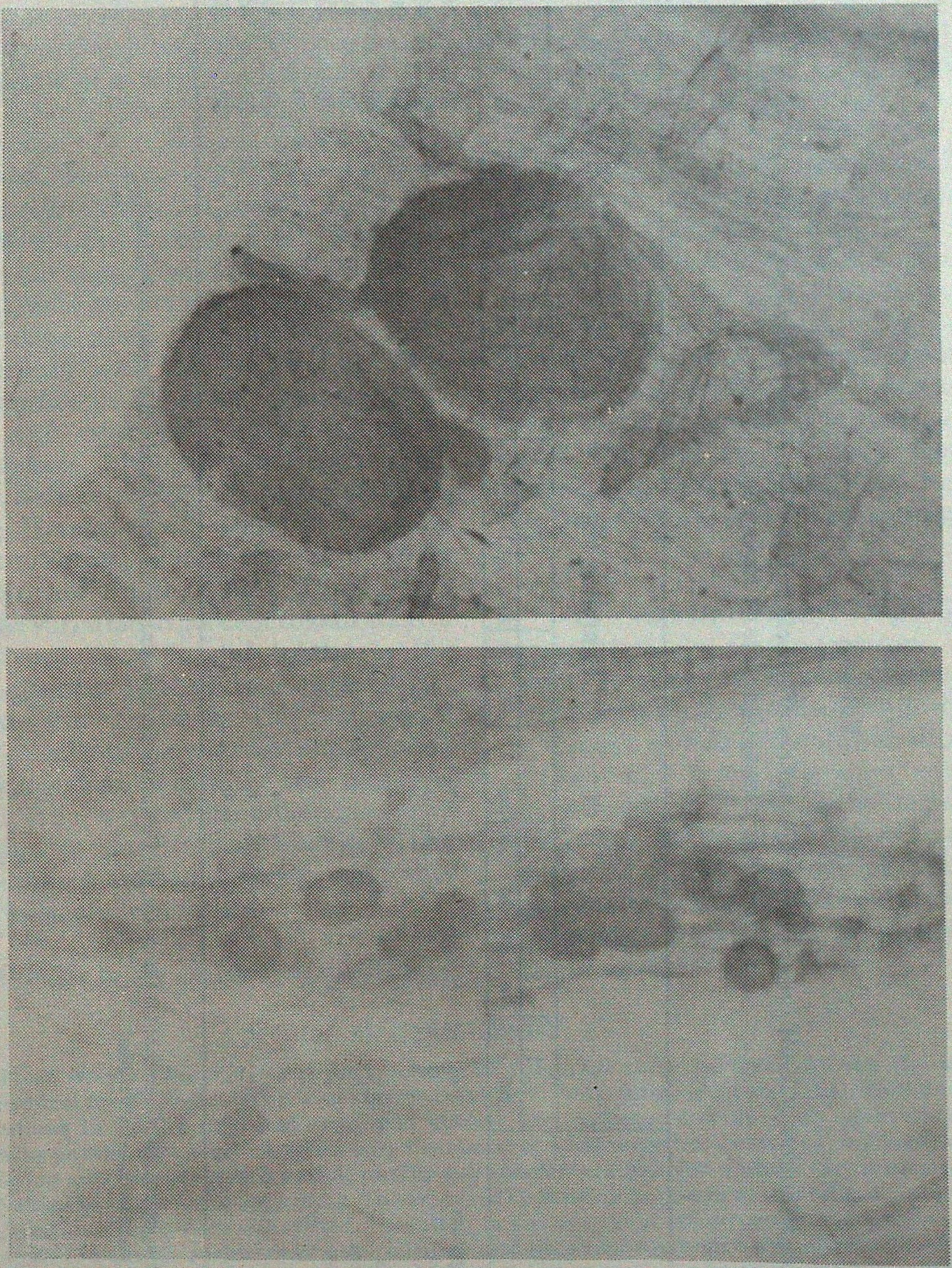
Status of VAM fungi in different plantations of *Acacia nilotica* and *A. tortilis* of Rajasthan are presented in Table 3. It can be observed from the Table 3 that maximum per cent colonization in the roots of *A. nilotica* collected from Chopasni site (74%) followed by Gudavoisinivion (66%) were highly significant in comparison to the samples collected from other sites. Minimum per cent colonization was noticed in the roots of *A. nilotica* collected from Mandore site (39%). The samples of *A. tortilis* collected from Mogera (92%) had highest root infection which was highly significant in comparison to the samples collected from other sites. Minimum per cent root colonization was quantified from the samples of *A. tortilis* collected from Jhalamand site (55%).

Similarly, maximum spore number was recorded from the rhizosphere of *A. nilotica* plants collected from Chopasni plantation (305) followed by Gudavoisinivion (292) and Mogera (289) which were significantly superior to the samples collected from all other sites but among themselves they were at par. In *A. tortilis*, maximum spore number was observed from the rhizosphere of plants collected from Mogera site (406) followed by Devlia (393) and Bapupura (370) which were significantly greater than the samples collected from rest of the plantations.

Frequency distribution of VAM fungi in the rhizosphere of Acacia spp. in plantations : The frequency distribution of different VAM fungi isolated from the rhizosphere soils of both *Acacia* spp. in plantation sites is shown in Table 4. A total of ten different species of VAM fungi belonging to two genera viz., *Glomus* and *Sclerocystis* were identified, of which, the genus *Glomus* was found to be the most dominant group. Among the different VAM fungi isolated, *Glomus aggregatum* was the most frequent fungus (70%) recorded from the rhizosphere of *A. nilotica* in different plantations of Rajasthan. Species of *G. fasciculatum* was found to be the next dominant fungus from the rhizosphere of *A. nilotica* (50%) and *A. tortilis* (60%), respectively.

The present study revealed that

Fig. 1



VAM fungal structures in the roots of *Acacia* spp.

(a) Globose to sub-globose shaped vesicles and hyphae in the root segment to *Acacia nilotica* (x 100)

(b) Group of vesicles and hyphae in the root segment of *Acacia tortilis* (x 100)

Table 4

Distribution of VAM fungi in the rhizosphere of Acacia nilotica (An) and A.tortilis (At) plants of various plantation sites in Rajasthan

VAM fungi	Sampling sites																				Site Frequency (%)	
	1		2		3		4		5		6		7		8		9		10			
	An	At	An	At	An	At	An	At	An	At	An	At	An	At	An	At	An	At	An	At	An	At
Glomus aggregatum	-	+	+	-	+	-	+	-	+	+	+	-	-	-	-	-	+	+	+	+	70	40
G. fasciculatum	-	+	-	-	-	+	+	+	-	-	+	-	-	+	+	+	+	-	+	+	50	60
G. fulvus	-	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	+	-	-	10	20
G. intraradices	+	-	-	+	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	30	10
G. macrocarpum	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	-	20	30
G. microcarpum	+	-	+	-	-	+	-	-	-	+	-	-	+	+	-	-	-	-	-	+	30	40
G. occultum	-	-	-	-	-	-	-	+	-	+	-	-	+	-	-	-	-	-	-	+	10	30
G. pubescens	-	-	-	+	-	-	+	+	-	-	+	+	-	-	+	-	-	+	-	-	30	40
Glomus sp.	-	+	-	-	-	+	+	-	-	-	+	+	-	-	-	+	-	-	-	-	20	40
Sclerocystis sp.	+	-	-	+	-	-	+	-	-	-	-	-	-	+	-	-	-	-	+	-	30	20

(1) Banar; (2) Bapupura; (3) Chaukha; (4) Chopasni; (5) Devlia; (6) Gudavoisinion; (7) Jhalamand; (8) Mandore; (9) Mogera; (10) Osean. (-) = Absent; (+) = Present

average per cent colonization in the roots (49.2%) and number of VAM fungal propagules (179.6) in the rhizosphere of *A. nilotica* seedlings in nursery stage were low as compare to *A. tortilis* seedlings (66.8 % root colonization and 234.0 fungal propagules) from various nursery sites screened. Whereas, average per cent root colonization (53.5% in *A. nilotica* and 73.6% in *A. tortilis*) and number of VAM fungal spores (225.1 in *A. nilotica* and 338.4 in *A. tortilis*) were comparatively more at various plantation sites. These observations corroborate with the research on VAM associations in important tree species of arid and semi-arid zones by other researchers (Mukerji and Kapoor,1986; Kiran Bala *et al*., 1989; Tarafdar and Rao, 1990; Thapar *et al*., 1991; Mohan and Neelam Verma, 1995; Mohan *et al*., 1995; Mohan and Singh, 1996). Their study showed variation in per cent colonization in roots and VAM fungal spores in the rhizosphere of different tree species under various site conditions. The intensity of VAM colonization in the roots and spores in the rhizosphere of both the tree species of *Acacia* in nursery and plantation sites varied according to age of the plant and site factors including soil nutrients, moisture and other environmental conditions.

Similar to our earlier investigation on native and exotic *Prosopis* spp. (Mohan and Singh, 1996), the introduced *A. tortilis* seems more dependent on mycorrhiza which is expressed in terms of higher root infection and recovery of fungal spores from the rhizosphere. Irrespective of site and age of sampling, exotic *A. tortilis* was more mycotrophic. When root infections and spore populations of *Acacia* spp. were analysed on frequency distribution, more sites for *A. tortilis* had fallen on the higher side of the scale making the gap between the two species more apparent. Can higher mycotrophy of *A. tortilis* be considered a survival mechanism for the exotic trees when they are introduced to new and harsh sites like arid zone ? Only seedlings inoculations with mycorrhiza and their field performance can answer such assumptions.

Two endomycorrhizal fungi, *Glomus aggregatum* and *G. fasciculatum*, having high frequency distribution, were isolated from the rhizosphere of both the *Acacia* spp. at nursery as well as plantation stage. The former was more frequent with the *A. nilotica* while the latter showed its preference for *A. tortilis*. Based on these observations, the mass multiplication of *G. aggregatum* and *G. fasiculatum* was initiated to inoculate *Acacia* seedlings for future studies.

SUMMARY

Most woody plants depend on mycorrhizal fungi for their survival. Among the different mycorrhizal fungi, Vesicular-Arbuscular Mycorrhizal (VAM) fungi are widely distributed in varied ecosystems including arid and semi-arid deserts and associated with many plant species. An intensive survey was conducted to study the status of VAM fungal associations in *Acacia* spp. viz., *A. nilotica* sub species *indica* and *A. tortilis* sub species *raddiana* of various forest nurseries and plantations in arid zone of Rajasthan. The extent of VAM colonization in roots and spore populations in rhizosphere soils were quantified. Variation in per cent root colonization and number of VAM propagules in the rhizoshpere of both nursery and plantation samples was observed. Also, mean number of VAM propagules and per cent root colonization were greater in plantation samples than in nursery samples. Spores from the rhizosphere soils were isolated and tentatively identified as different species of *Glomus*, *Gigaspora* and *Sclerocystis* genera of endomycorrhizal fungi. Among these genera, *Glomus* is dominant in the rhizosphere of both the tree species screened. The most predominant VAM fungi were multiplied for future nursery inoculations.

भारतीय शुष्क क्षेत्र की रोपणियों और रोपवनों में लगे *अकेसियाओं* में अन्तर्कवकमूलीय साहचर्य

वी० मोहन व वाई०पी० सिंह

सारांश

बहुत से काष्ठीय पादप अपनी अतिजीविता के लिए कवकमूलीय कवकों पर निर्भर हैं । विभिन्न कवकमूलीय कवकों में से वैम कवक तरह-तरह की पारिस्थितिकीय संहतियों में दूर-दूर तक फैले हुए हैं जिनमें शुष्क और अर्ध शुष्क मरूभूमियाँ भी आती हैं और उनका बहुत सी पादप जातियों के साथ साहचर्य देखा जाता है । राजस्थान के शुष्क प्रदेशों में बनाई हुई विभिन्न वन रोपणियों और रोपवनों में लगी *अकेसिया* की जातियां उदा० *अकेसिया नीलोटिका* की *इण्डिका* उपजाति और *अ० टोर्टाइलिस* की *राड्डियाना* उपजाति के साहचर्य में पाए जाने वाले वैम कवकों की स्थिति का अध्ययन करने के लिए एक गहन सर्वेक्षण कराया गया । जड़ों में वैम कवकों के उपनिवेशन और मूल जीव मण्डल मृदाओं में बीजाणुओं की संख्या का मात्रांकन किया गया । वैम प्रवर्ध्यों के जड़ों में उपनिवेशन के प्रतिशत तथा रोपणी और रोपवन दोनों से लिए नमूनों में वैम प्रवर्ध्यों की संख्या का अन्तर प्रेक्षित किया गया । रोपणी नमूनों की तुलना में रोपवन से लिए गए नमूनों में वैम कवकों की माध्य संख्या और जड़ों में उनका उपनिवेशन प्रतिशत अधिक पाया गया । मूलजीवमण्डल मृदा के बीजाणु पृथक किए गए और अन्तरिम रूप से उनकी पहचान अन्तर्कवकमूलीय कवकों की *ग्लोमस*, *गीगास्पोरा* और *स्केलेरोसिस्टिस* प्रजातियों की विभिन्न जातियों से की गई । इन प्रजातियों में पड़ताली गई दोनों वृक्ष जातियों के.मूलजीवमण्डल में *ग्लोमस* की बहुलता है । सर्वाधिक प्रमुख वैम कवकों को भविष्य में रोपणी में उनके टीकाकरण कार्य के लिए बहुलित कराया गया ।

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PHENOTYPIC STABILITY OF *AGAVE* SPECIES ON BOULDERY WASTELANDS (RIVERBED) OF DOON VALLEY

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Introduction

The National Commission on Agriculture (Anon., 1976) estimated that about 15 per cent of the total geographical area of the country is covered by wastelands. These wastelands generate the maximum amount of sediment and runoff due to wind and water erosion. Therefore, on such wastelands, permanent vegetative cover, both for protection and production, with effective soil and water conservation measures is recommended. In the North-West Himalayan region, the denuded wastelands have serious limitations of slope, stoniness and soil depth and are subjected to the processes of erosion as a result overgrazing and other anthropogenic factors. *Agave* is one of the most suitable hardy plants, which can profitable be raised even on such denuded wastelands where nothing else can be grown (Gupta, 1982; Gupta *et al.*, 1989; Shah, 1974). Moreover, *Agave* is capable to check erosion due to its soil binding capacity, orientation of leaves with reference to its stem and can provide protection to the wastelands from excessive grazing animals. Generally, the corridor between the two rows along the contours of *Agave*, as recommended may be planted with suitable legumes, grasses etc., for better economic utilization and conservaiton of the slopes. *Agave* is also resistant to saline water and is one of the strongest fibres, being always in demand in mercantile industry, having many other commercial uses in the different traits (Anon., 1985).

Different *Agave* species have been introduced and cultivated in various soil-climatic zones of India. Intensive research on Phenotypic stability for various agricultural and horticultural crops etc., has been carried out. Sporadic researches on the phenotypic stability of forest trees and grasses have been done (Bhati *et al.*, 1985; Singh and Khanna, 1989; Solanki *et al.*, 1984; Yadava *et al.*, 1974). Stability of *Agave* species has not yet been worked out. An attempt has been made in this article to identify the most stable *Agave* species under conditions of bouldery riverbed Wastelands of Doon Valley.

Materials and Methods

The study was conducted at the Research Farm of the Central Soil and Water Conservation Research and Training Institute, at Selakui (30°21' N latitude, 70°52' E longitude and at an altitude of 517 m above m.s.l) about 16 km North-West of Dehra Dun. The riverbed soil was having a depth of 25-30 cm with 50 to 60 per cent gravel and boulders (by weight). The soil was predominantly loamy sand with pH of 8.0. The organic carbon content in the soil varies from 0.3 to 0.4 per cent. Available phosphorus and potash were 90-95 and 125-250 kg/ha respectively. The average annual rainfall was 1672 mm. The maximum temperature goes upto 45°C during summer months in May while the minimum was recorded as low as 0° during January in winter.

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Bulbils of seven species of *Agave*, of uniform size and age, (viz. *amaniensis, angustifolia, cantala, elongata,* hybrid, *miradoransis* and *sisalana*), received from Central Sisal Research Station, Bamra (Orissa) of the Jute Agricultural Research Institute, Barrackpore (West Bengal) obtained in the year 1980 were transplanted at Dehra Dun Research Farm in the month of July at a spacing of 240 cm x 120 cm in rows by digging pits of 45 cm^3 size.

The growth characteristics (plant height, crown spread, number of leaves, leaf length and leaf width) were recorded in the month of April for four years (1982 to 1985) from five randomly selected plants from each species. 50 per cent of *Agave* leaves were harvested as per the earlier recommendations (Gupta *et al.*, 1986) and processed for fibre extraction by retting. The fibre yield (gm/plant) were recorded after air drying the fibres from 1983 to 1985.

The statistical analysis and pooled analysis of the data was done separately for each of the characters under study. The growth characters as well as the fibre yield were also statistically analysed for stability parameters as per Eberhart and Russell model (1966). The stability parameters i.e., mean, regression coefficient (bi) and deviation from regression (S^2di) were calculated to identify the most suitable stable *Agave* species under bouldery riverbed conditions of wastelands of Doon Valley.

Results and Discussion

The stability analysis of variance showed that the difference between *Agave* species were significant for all the growth characters and as well as for fibre yield (Table 1 and 2). the environments also appeared to be significantly different from one another. The mean square due to species

Table 1

Analysis of variance for stability of various growth characters for different Agave species in bouldery riverbed of Doon Valley

Source	DF	Mean sum of square due to			Average leaf	
		Plant Height (cm)	Crown spread (cm)	No. of Leaves/ Plants	Length(cm)	Width (cm)
Species (s)	6	3681.10++	11179.70++	2563.27++	5506.26++	9.7389++
Environments (E)	3	5839.10++	6665.78++	3269.11++	2398.95++	5.5457++
S x E	18	366.88++	1594.31++	623.02++	409.57++	1.4010++
E + S x E	21	1148.63++	2318.80++	1001.03++	693.77++	1.9931++
E (Linear)	1	17517.44++	19997.03++	9807.42++	7196.84++	16.6408++
S x E (Linear)	6	646.34++	1646.84++	390.63++	1058.55++	2.5889++
Pooled deviation	14	194.69++	1344.05++	633.60++	72.93++	0.6915++
Pooled error	112	51.84	113.11	48.75	21.20	0.1302

Against pooled error: ++ P = 0.01,+ P=0.05

Table 2

Analysis of variance for stability of fibre yield for different Agave species in bouldery riverbed of Doon Valley

Source	DF	Mean sum of square
Species (s)	6	29874.37++
Environments (E)	2	311594 .01++
S x E	12	16145.67++
E + S x E	14	58352.58++
E (Linear)	1	623176.45++
S x E (Linear)	6	29449.36++
Pooled deviation	7	2437.64++
Pooled error	84	240.49

Against pooled error ++ = P = 0.01, + = P = 0.05

x environmental interaction was highly significant for all the characters revealing thereby that the species interacted considerably with the environmental condition that existed over different seasons and also indicated that the regression coefficients (bi) of different species were not of the same order. Highly significant environment (linear) component suggested considerable differences among environments and their predominant effect on the characters exists. The linear component of environmental interaction with varieties [i.e. VXE (L)] was also found to be significant for all the characters under study. Thus, the results revealed that the amount of variability existed not only among species but also in the environments from year to year. The variance due to pooled deviation (non-linear) was significant for all the growth characters and fibre yields indicating that all the species differed considerably in respect to their stability for different growth characters and also the fibre yield.

A particular species could be considered stable under deferent environments if it had high mean value above the General mean, regression coefficient, (bi) is not far deviated from the unit value with non-significant lowest deviation from regression. As such all the three parameters mentioned above, were estimated for each character separately and are discussed (Tables 3 and 4).

For height, two species of *Agave* viz. *A. angustifolia* and *A. cantala* had significant S^2di. The regression coefficients of three species of *Agave* viz. *A. angustifolia, A.* hybrid and *A. miradoransis* were deviated form unity. The species of *A. amaniensis, A. elongata. A.* hybrid and *A. sisalana* had shown good height performance than the general mean, while the height performance of *A. angustifolia, A. cantala* and *A. miradoransis* were less than the general mean. Hence, *A. amaniensis, A. elongata* and *A. sisalana* were found to be stable species of *Agave* for height growth performance.

For crown spread, five species of *Agave* viz. *A. amaniensis, A. angustifolia, A. cantala, A.* hybrid and *A. sisalana* had significant S^2di. The regression coefficients of the four *Agave* species viz. *A. amaniensis, A. angustifolia, A. miradoransis* and *A. sisalana* deviated from the unity. *A. amaniensis, A. elongata, A.* hybrid *and A. sisalana* showed high crown spread performance than the general mean. While *A. angustifolia, A. cantala* and *A. miradoransis* had shown poor crown spread performance than the general mean. Hence *A. elongata* was found to be the only stable *Agave* species for crown spread character.

For the number of leaves, it has been observed that four *Agave* species viz. *A. angustifolia, A. cantala, A.* hybrid and *A. miradoransis* had significant S^2bi. The

Table 3

Stability parameters for height, crown spread and number of leaves/plant for different Agave species

Species	Plant height (cm)			Crown spread			No. of leave/plant		
	mean	bi	S²di	mean	bi	S²di	mean	bi	S²di
Agava amaniensis	181.4	+1.161*	+39.5	230.2	+1.792+	+1384.3**	42.1	+0.704	+14.2
A. angustifolia	126.9	+0.511+	+249.3**	130.4	-0.012+	+372.1*	90.3	+1.277	+2152.6**
A. cantala	161.6	+0.959	+556.4**	169.2	+0.594	+1188.7**	53.9	+0.707	+965.0**
A. elongata	177.2	+1.064*	+34. 5	204.1	+1.233**	-106.5	41.3	+0.352+	+1.4
A. hybrid	201.5	+1.877+*	124.7	255.0	+1.141	+4338.0**	76.9	+1.778+*	+182.9*
A. miradoransis	118.5	+0.298+	-21.2	117.9	+0.249+	-98.3	98.0	+1.527+	+795.9**
A. sisalana	178.7	+1.129*	+16.7	229.5	+2.002	+1538.3**	36.6	+0.654*	-17.8
Pupulation mean	163.6			190.9			62.7		
S.E. (mean)	9.6			20.0			12.5		
S.E. (bi)		0.192			0.287			0.200	

+ denoted deviation of regression coefficients from unity. *, ** denotes significant at 5% and 1% respectively.

Table 4

Stability parameters for leaf length, leaf width and fibre yield of different Agave species.

Species	Leaf length (cm)			Leaf width (cm)			Fibre yeild (gm/plant)		
	mean	bi	S²di	mean	bi	S²di	mean	bi	S²di
Agave amaniensis	151.7	+1.452	+260.8**	11.6	+2.638+,*	+0.3	364.2	+0.959	+4323.3**
A. angustifolia	68.3	-0.704+,**	-20.8	8.4	-0.700+	+0.3	136.2	+0.500	+2388.9**
A. cantala	112.3	+1.952+,+	+81.7	9.6	+1.489	+1.6**	250.3	+0.780*	-74.2
A. elongata	127.5	+1.477*	+17.9	10.0	+1.382	+0.2	224.5	+0.356+*	-196.7
A. hybrid	137.0	+2.008+,**	-7.4	11.0	+1.212	+1.6**	401.4	+2.098+	4538.5**
A. miradoransis	51.5	+0.076	-8.0	7.6	+0.415	+0.1	186.0	+1.190	4129.6**
A. sisalana	128.0	+0.739	+37.9	11.6	+0.565*	-0.1	348.9	+1.137*	+270.7
Population mean	110.9			9.9			273.0		
S.E. (mean)	10.1			0.6			73.4		
S.E. (bi)		0.384			0.394			0.217	

+ denotes deviation of regression coefficients from unity. *,** denotes significant at 5% and 1% respectively.

regression coefficient of three *Agave* species viz. *A. elongata, A.* hybrid and *A. miradoransis* deviated from the unity. Three *Agave* species viz., *A. angustifolia, A.* hybrid and *A. miradoransis* produced higher number of leaves than the general mean while four *Agave* species viz., *A. amaniensis, A. cantala, A. elongata* and *A. sisalana* produced less number of than the general mean. Hence no *Agave* species was found to be stable for number of leaves per plant.

For leaf length, two *Agave* species viz. *A. amaniensis* and *A. cantala* had significant S^2di. The regression coefficients of three *Agave* species viz., *A. angustifolia, A. cantala* and *A.* hybrid deviated from the unity. The leaf length of two *Agave* species viz., *A. angustifolia* and *A. miradoransis* were less than the general mean. Hence *Agave* species *A. elongata* and *A. sisalana* were the only stable *Agave* species for leaf length.

For leaf width, two species of *Agave* viz., *A. cantala* and *A.* hybrid had significant S^2di. The regression coefficient of the two species viz., *A. amaniensis* and *A. nagustifolia* deviated from unity. The leaf width of three species viz., *A. angustifolia, A. cantala* and *A. miradoransis* were less than the general mean. Hence two species *A. elongata* and *A. sisalana* were only stable for leaf width.

For fibre yield, four species of *Agave* viz., *A. amaniensis, A. angustifolia, A.* hybrid and *A. miradoransis* had significant S^2di. The regression coefficients of the two species viz., *A. elongata* and *A.* hybrid deviated from the unity. The species *A. angustifolia, A. cantala, A. elongata* and *A. miradoransis* produced less fibre yield than the general mean but fibre yield of *A. cantala* was within 10% limit of the general mean. Hence, *A. cantala* and *A. sisalana* were the only stable species for fibre yield performance.

Conclusion

Seven *Agave* species were studied for their phenotypic stability on bouldery riverbed wastelands of Doon Valley. It is concluded that *A. angustifolia, A.* hybrid and *A. miradoransis* did not shown stable performance for any of the characters under study. *A. amaniensis* and *A. cantala* was stable performance for one character only. While, *A. elongata* has shown stable performance for four growth characters (viz. height, crown spread, leaf length and width). *A. sisalana* has shown stable performance for three growth characters (viz., height, leaf length and width) and fibre yield also. *Agave sisalana* was found to be the only stable species and hence recommended for mass adoption on bouldery riverbed wastelands of Doon Valley. *Agave sisalana* was among first introduced species in India and has completely naturalized in the region and is stable.

Acknowledgements

The authors are grateful to the Director, Cental Soil and Water Conservation Research and Training Institute, Dehra Dun, for the facilities provided for conducting this study. The authors are thankful to Mr. K.M. Gaikwad for the help provided in recording the field data and its tabulation, to Shri Roopak Tandon for computational help and to Ms. Nisha Verma for typing the manuscript.

SUMMARY

Study on seven species of *Agave* (viz., *amaniensis, angustifolia, cantala, elongata,* hybrid, *miradoransis* and *sisalana*) was carried out to identify the most stable *Agave* species under bouldery riverbed wastelands of Doon Valley. The analysis of the data indicated that the amount of variability existed not only among species but also in the environments. All these species differed considerably in respect to their stability for different characters under study. Three *Agave* species (viz., *A. angustifolia, A.* hybrid and *A. miradoransis*) did not show stable performance at all, while two species of *Agave* (viz., *A. amaniensis* and *A. cantala*) has shown stable performance for one character only. *Agave elongata* showed stable performance for four growth characters, while *Agave sisalana* has shown stable performance for three growth characters and also for the fibre yield. *Agave sisalana* was found to be the only stable *Agave* species and hence could be recommended for mass adoption on bouldery wastelands of Doon Valley.

दून घाटी की चट्टानी बंजरभूमियों (नदी पाट) में वनकुमारी की जातियों का दृश्य रुप स्थायित्व

आर०के० गुप्त, एम०सी० अग्रवाल व पी० जोशी

सारांश

वनकुमारी की सात जातियों (अर्थात *अगेव अमानिएसिंस, अ० अंगुस्टिफोलिया, अ० कंटाला, अ० इलोंगेटा, अ० मिराडोरेसिंस, अ० हाइब्रिड* और *अ० सिसलाना*) का अध्ययन दून घाटी की नदी पाट की बंजरभूमियों में सबसे अधिक स्थाई रहने वाली जाति का पता लगाने के लिए किया गया । प्राप्त हुए आंकडों के विश्लेषण से पता चला है कि अन्तर केवल जातियों में ही नहीं है वह पर्यावरण में भी पाया जाता है । इस अध्ययन में सभी जातियों में लक्षणों की दृष्टि से भी स्थायित्व में काफी अन्तर मिलता है । *अगेव* की तीन जातियों (अर्थात अ० अंगुस्टिफोलिया, अ० हाइब्रिड और अ मिराडोरेसिंस) में कुछ भी स्थाई रही ही नहीं जबकि वनकुमारी की दो जातियां अर्थात् अ० अमानिएसिंस और अ० कंटाला में एक लक्षण के लिए ही स्थायित्व दिखाई पड़ा । अ० इलोंगेटा में वृद्धि के चार लक्षणों की स्थाई सक्रियता देखी गई जबकि *अ० सिसलाना* में तीन लक्षण तथा रेशे की प्राप्ति में स्थाई सक्रियता दिखाई पड़ी । *अगेव* की जातियों में केवल *अगेव सिसलाना* ही एकमात्र स्थाई जाति रही और इसलिए उसे ही दून घाटी की चट्टानी बंजरभूमियों पर बड़े परिमाण में अपनाने के लिए सिफारिश की जानी चाहिए ।

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Snippets FOREST MAP

The first map of forest types and densities for the entire coterminous United States has been generated using coregistration of Advanced Very High Resolution Radiometer (AVHRR) data and Landsat Thematic Mapper (TM) data; regression analysis determined the statistical relationships between the two data types. Forest density was defined as the percentage of forested TM cells within an AVHRR cell. The process could be applied to other remote sensing projects using a primary, inexpensive data set for total enumeration; and a secondary, more accurate data sample to refine the analysis. The forest density map will contribute to understanding of forest type distribution at the landscape level; to defining the extent of forest land in a region; and to recognizing patterns of global change among countries with varying forest land definitions.

Source: *Forest Density Mapping in the Lower 48 States: A Regression Procedure*. Research Paper SO-280, Southern Research Station, 1994.

GERMINATION STUDIES ON A FEW MULTIPURPOSE NITROGEN FIXING TREE SPECIES USED IN AFFORESTATION PROGRAMMES IN CENTRAL HIMALAYA

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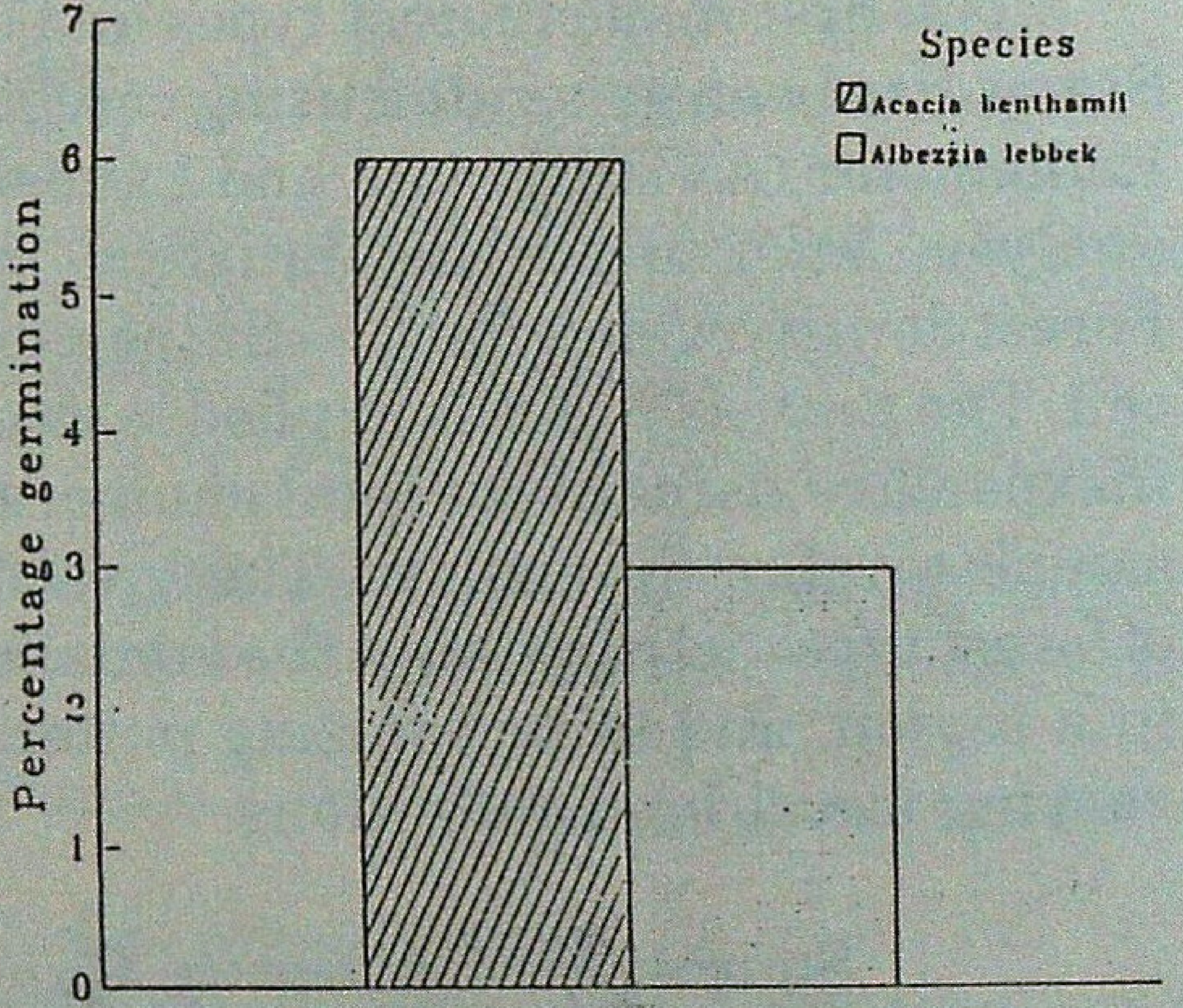
Introduction

Requirements of viable seeds or planting stock for the success of ongoing afforestation/reforestation schemes in the country is prime. Multipurpose trees and specially nitrogen fixing ones are preferred by the local population in the hills for their additional uses such as fuel, fodder, minor timber etc. However, the current levels of seed production from the known sources do not always fulfill the requirements and additional seed sources are always needed to meet the growing demands. The problem is further exacerbated by the difficulty in germination of the seeds collected from various regions. Most legume seeds have hard coat which contributes to long viability and easy storage. These seeds need some sort of pre-treatment before sowing to improve their germination. In the present paper four tree species seeds collected from Tarai seed stock areas were tested for their germination in the mid-Himalayan elevations at Almora. The species selected were nitrogen fixing, valued for their timber/wood and fuelwood in the U.P. Hills (Saxena *et al.*, 1990).

Materials and Methods

Seeds of *Acacia benthemii*, *A. farnesiana*, *Albizia lebbek* and *Cassia fistula* were collected at seed stock areas in the foothills near Ramnagar. These seeds were subjected to (1) sowing in the nursery beds without pre-treatment; (2) germinated in petridishes placed in germinator with following treatments at 26 °C temperatures : (a) no pre-treatment (Control) (T_1; (b) imbibed in cold water for 30 minutes (T_2); (c) imbibed in hot (80 °C) water for 30 minutes (T_3); (d) mechanically scarified at micropylar end with sharp pin without damaging the internal structures (T_4); and (e) mechanically rubbing against sandpaper to disturb the seed coat (T_5). Each treatment was given a

Fig. 1



Germination of selected nitrogen fixing tree species seeds in nursery beds in Almora

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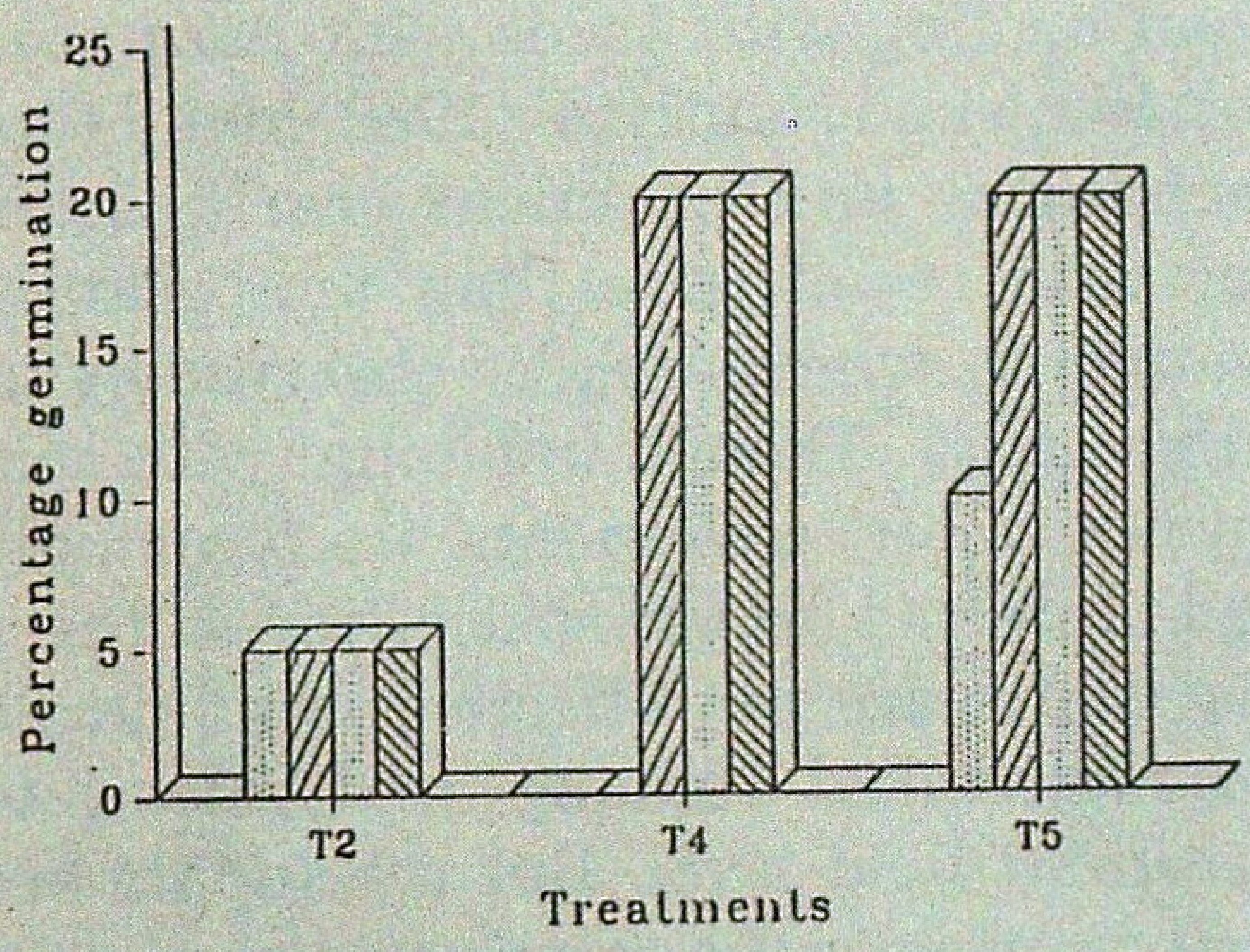
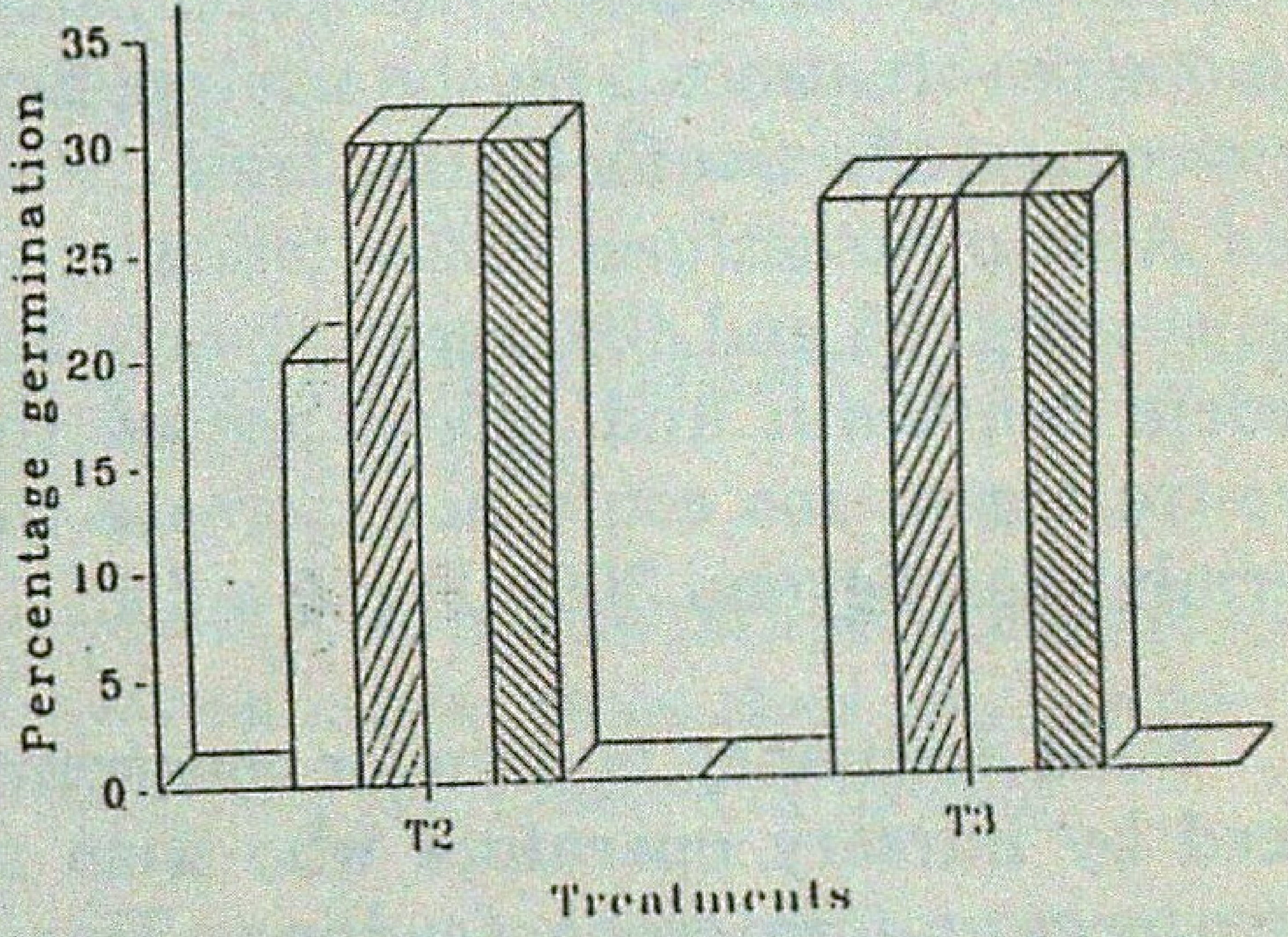
Fig. 2a



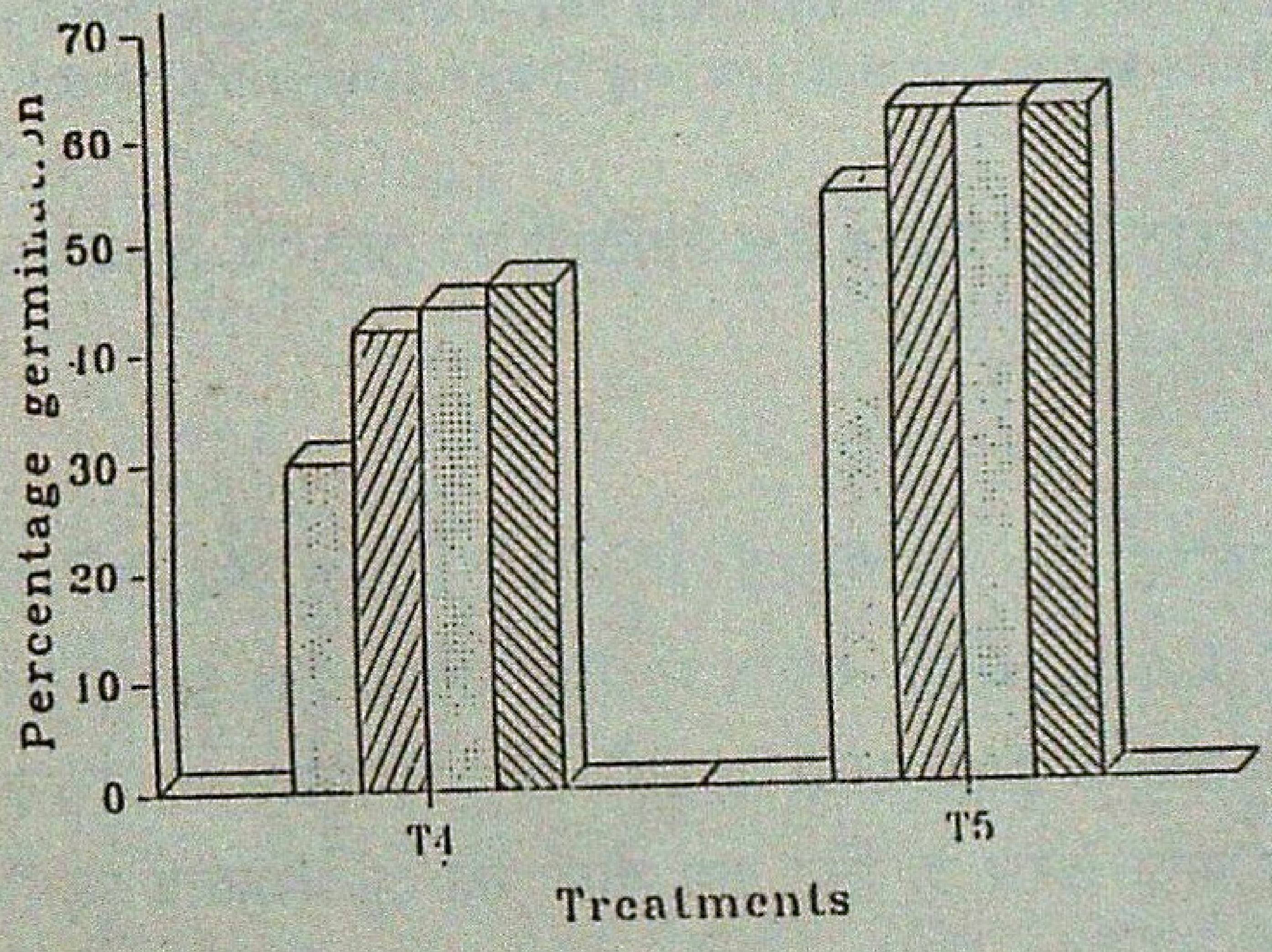
Germination of *Acacia benthemii* seeds in germinator at 26°C

Fig. 2c



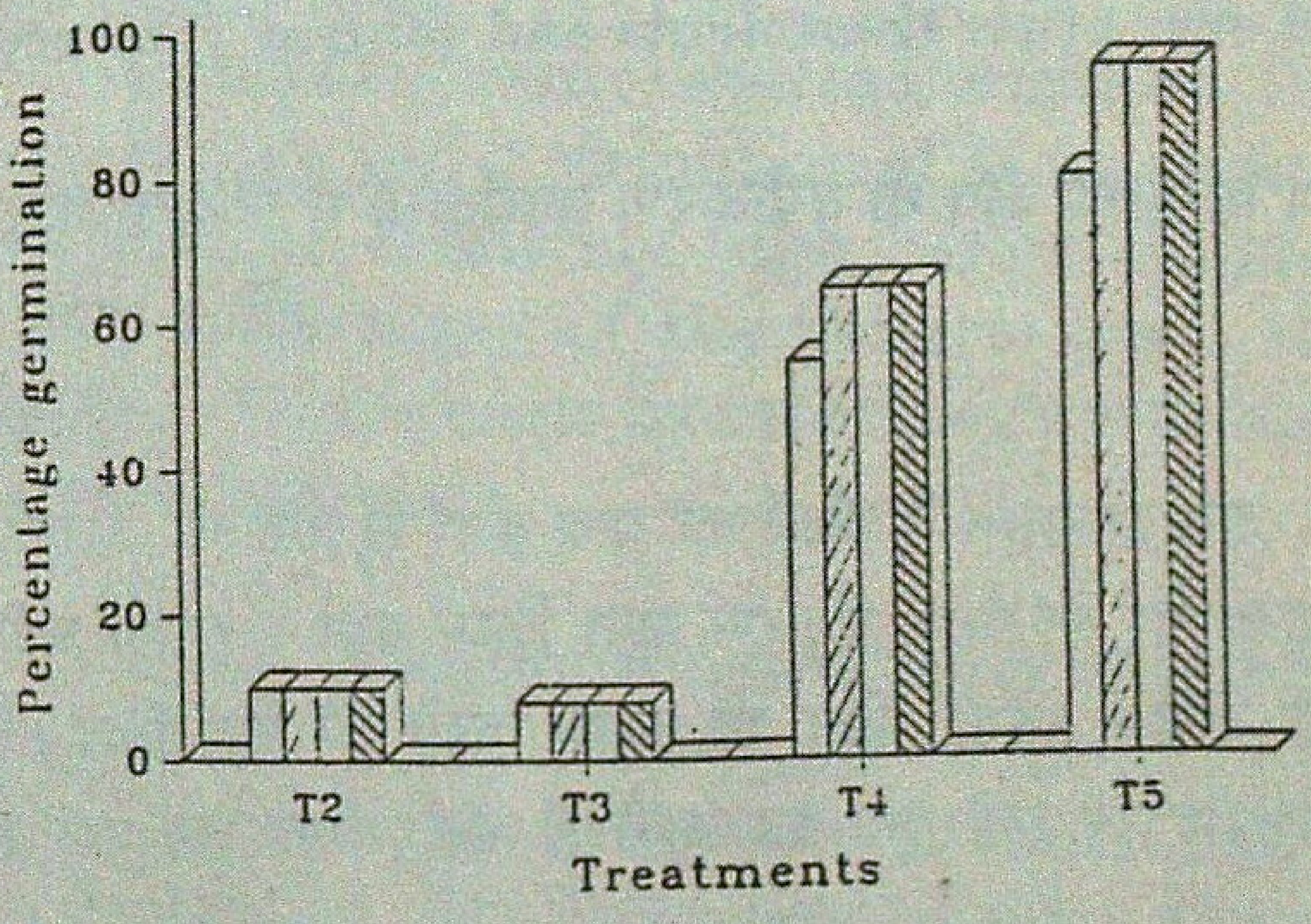
Germination of *Albizia lebbek* seeds in germinator at 26°C

Fig. 2b



Germination of *Acacia farnesiana* seeds in germinator at 26°C

Fig. 2d



Germination of *Cassia fistula* seeds in germinator at 26°C

set of 25 seeds in four replicates during May-June 1995. Daily germination (emergence of radicle) was noted for 30 days. The petridishes were moistened with distilled water and nursery beds with tap water to keep the moisture levels optimum.

Results and Discussion

Seeds without any treatment in nursery beds showed least germination. Only *Acacia benthemii* and *Albizia lebbek* showed some germination (Fig. 1), the highest being 6%

in *A. benthemii*. In contrast, seeds when germinated without any pre-treatment (control) in petridishes none has germinated. Among pre-treatments mechanical rubbing proved most effective for *Cassia fistula* (95%) and *Acacia farnesiana* (62%) followed by puncturing (65 and 46% respectively). For *Acacia benthemii* and *Albizia lebbek* the pre-treatment too could not increase the germination beyond 30% (Fig. 2 a-d).

Seed dormancy is a major constraint faced by nursery operators who wish to have large uniform crops of sedlings. This is specifically true for species with hard seed coat. Thus the methods of treating the seeds are both of physiological and practical importance (Kramer and Kozlowski, 1979). When dealing with seeds with hard seed coat, Rana and Nautiytal (1989) found that mechanical and chemical scarification proved more effective than temperature treatments, which are also observed by us in this study. Though imbibing (with cold and hot water) treatments are commonly used/preferred for the species tested these treatments are not effective. Puncturing and mechanical rubbing are difficult to operate at field level. But the inputs are worth putting as the germination rates are many fold greater and with less seed large uniform stock could be achieved.

SUMMARY

In this study better germination was obtained by mechanical scarification for *Acacia farnesiana, A. benthemii, Albizia lebbek* and *Cassia fistula*. Though it will be difficult to implement in nursery requiring large stocks, the effeort is recommended as germination rates increased many fold over other treatments and control, thus requiring less seed for achieving large uniform stock.

मध्य हिमालय क्षेत्र के वनीकरण कार्यक्रमों में उपयुक्त नाइट्रोजन स्थिरक बहुप्रयोजन वृक्ष जातियों का अंकुरण अध्ययन

उर्मिला राणा व के०एस० राव

सारांश

इस अध्ययन में बीजों को यन्त्र द्वारा खुरचने पर *अकेसिया फार्नेसियाना, अ० बेन्थमिआई, एल्बिजिया लेब्बेक* और *केसिया फिस्टुला* का श्रेष्ठतर अंकुरण प्राप्त किया गया । यद्यपि बड़ी रोपणियों में जहाँ अधिक संख्या में पौधे चाहिएं, इसे क्रियान्वित करना कठिन रहेगा फिर भी प्रयास करने की सिफारिश की जाती है क्योंकि इससे अन्य उपचारों और नियामक की तुलना में अंकुरण दरें कई गुना बढ़ जाती हैं और फलतः बड़े एक समान पौधे प्राप्त करने के लिए कम बीजों की आवश्यकता पड़ती है ।

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RESEARCH NOTES

(I)

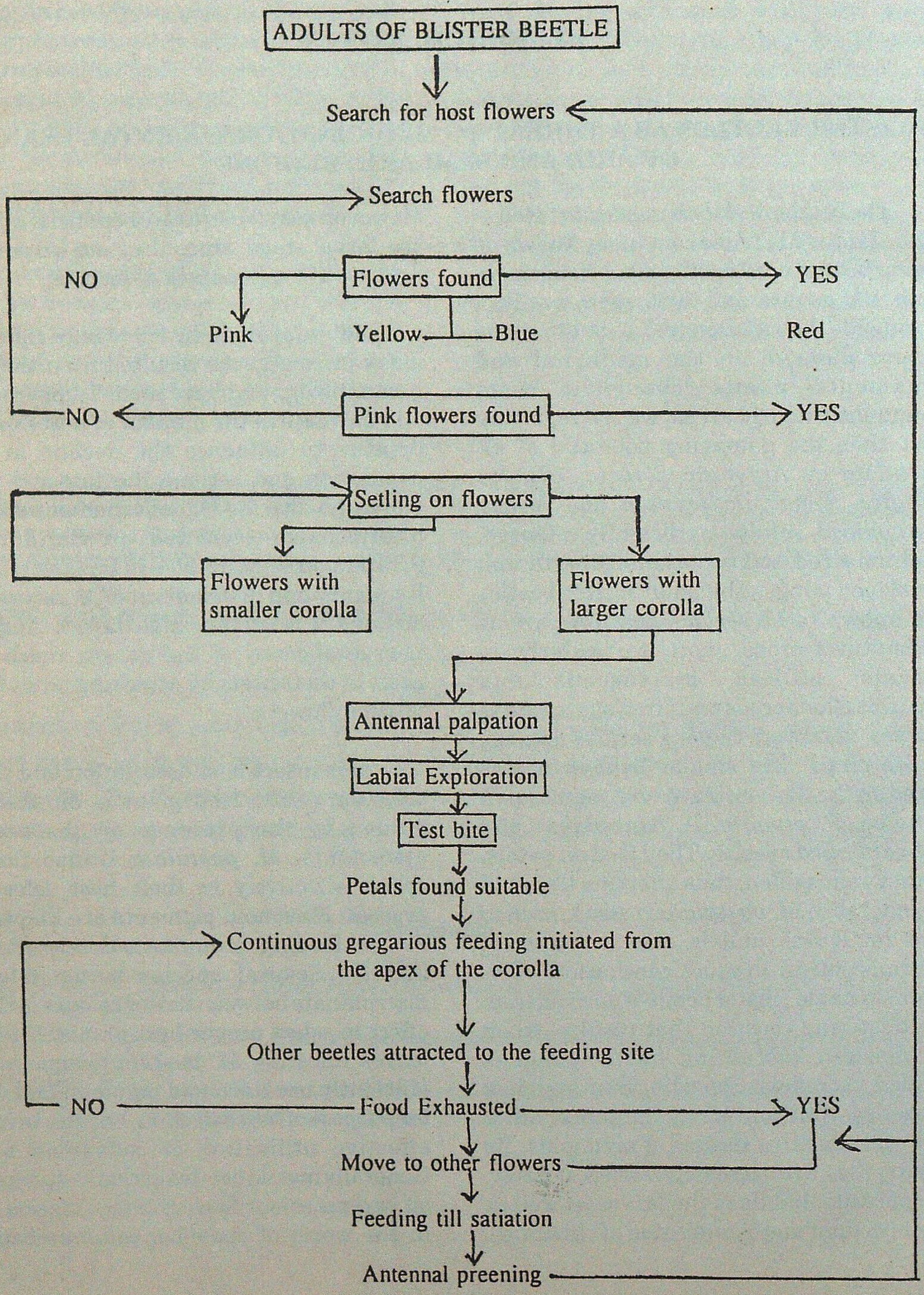
BLISTER BEETLES AS A THREAT TO MEDICINAL/ORNAMENTAL PLANTS OF ARID AND SEMI-ARID REGIONS

The beetle, *Mylabris pustulata* belongs to the family Meloidae commonly known as blister beetles or oil beetles comprising more than 100 genera and 2000 species with a worldwide distribution and found to cause severe damage on the medicinal and ornamental plants. Though it exists abundantly in arid areas, we are reporting first time the damaging potential of *M. pustulata* on *Argyreria nervosa, Clitoria ternatea, Pongamia pinnata* and *Acacia leucophloea*. Adults are brightly coloured, medium sized, soft bodies insects with well developed wings. The adult blister beetles are known to be serious pests of various agricultural crops, more particularly on cereals, millets, malvaceous and cucurbitacious crops and often aggregate in masses on flowers causing serious damage to the crops. The similar behaviour was noted on the flowers/leaves of *A. nervosa, C. ternatea, P. pinnata, A. leucophloea* and *Bougainvillea* species. They feed on petals, anthers and pollen, thus affecting the yield considerably. *M. pustulata* is also known to feed on leaves and is also a source of pharmaceutical product cantharidin. The common name, blister beetle is derived from the blistering reaction that results when cantharidin containing haemolymph is exuded, via reflexive bleeding from leg joints of beetles while contacting the skin or other soft and sensitive tissues of mammals. By habits, they are extremely varied, notably, the parasitic habits of the larvae as well as their peculiar and complicated life histories. However, some species are beneficial during the larval stage, since they are known to destroy the egg-masses of locusts.

Adults are usually following a rain and delay in emergence resulted from the soil becoming dry and hardened. Temperature and decrease in the number of host flowers appears to influence the decline in the population and become the unusual pest status on the medicinal/ornamental host plants, also recorded on Sandal by Sivaramakrishnan (1984) in Bangalore. The frequency and distribution of *M. pustulata* activity is relatively high before August. Larvae of many of the genera reach the nests of their hosts by attacking adult bees visiting flowers.

This insect-host association and their selection of the food plant is directed or guided by the presence or absence of attractants. *M. pustulata* utilize flower colour effectively in their host selection process. Flavonoid pigments are known to act as feeding stimulants/deterrents in insect. Several species being able to discriminate between flower colours in their effect to select proper host plants. Flower/leaves infesting *M. pustulata* appears to efficiently use flavonoid pigments not only for purpose of host selection, but also involve effective utilisation of consumed food. Generally meloid beetles exclusively depend on various colour flowers. Since insects live in the world of chemical communication,

FLOW DIAGRAM INDICATING THE FEEDING BEHAVIOUR OF BLISTER BEETLE


ADULTS OF BLISTER BEETLE
Search for host flowers
Search flowers
NO
Flowers found
YES
Pink
Yellow
Blue
Red
NO
Pink flowers found
YES
Setling on flowers
Flowers with smaller corolla
Flowers with larger corolla
Antennal palpation
Labial Exploration
Test bite
Petals found suitable
Continuous gregarious feeding initiated from the apex of the corolla
Other beetles attracted to the feeding site
NO
Food Exhausted
YES
Move to other flowers
Feeding till satiation
Antennal preening

they are able to detect the volatiles of flower at some distances and as it reaches near the host plant, it also receives a visual signal in the contrasting colour of the flower. Flower colour results from the preferential absorption of part of the visible light by one or several chemical compounds synthesized by plants. The colour signals emerging from the flowers are message interpretable by insects. The pigments responsible for flower colour are essentially flavonoids and are located in the cell vacuoles. They are divided into several groups of which the anthocyanins are also included. Anthocyanins provide most of the pink, orange, red, violet and blue colour flowers. Chalcones, aurones and yellow flavonols contribute sometimes to yellow flower viz. *Tephrosia purpurea, Ipomaea* spp (pink colour), *Gossypium hirsutum, Lantana camara* (yellow rose, violet and red colours), *Cucurbita maxima* and *Luffa cylindrica* (yellow colour) showed the presence of some of the common anthocyanidins (Anthocyanin), pelargonidin, cyanidin and peonidin; flavones like apigenin, tricin, flavonols like myricetin and gossypetin in *T. pupurea, Ipomaea* spp., *Ruellia tuberosa,* and *L. camara* as well as yellow flavonols like 4'-glucoside (chalcones), aureusidin-6-glucoside (Aurones) while B-caotene (Carotenoids) in *C. maxima* and *L. cylindrica*. The most preferred host flower of meloid beetles i.e. *T. pupurea, G. hirsutum* and *Ipomaea* spp. tend to have these compounds in sufficient amounts to attract these beetles towards the host flower and make them to feed more on them and accumulation of these compounds in higher or low concentration in the less preferred host plant to be effective in reducing food consumption and destroying palatability (Murugesan, 1988). That the variation in the amount of food consumption by meloid beetles on different flowers, determined by the flower pigments may also be due to the presence of flavnoids with a specific combination with sugar is considered a significant feature in the relationship.

The damage cause by the blister beetles especially on the malvaceous, convolvolaceous, acanthaceous, medicinal and ornamental plants resulting in total crop loss has caused great concern to entomologists. And its host shifting especially on *A. nervosa, C. ternata, P. pinnata* and *A. leucophloea* is a clear warning signal to other valuable medicinal/ ornamental plant of this arid region since their peculiar and complicated mode of life histories.

A. nervosa commonly known as elephant creeper flowers are rose-purple colour having very good medicinal value for gleet, gonorrhoea, strangury and chronic ulcers. It is also grown as an ornamental. In Assam and Bihar, the leaves are eaten as vegetables. They are used externally in the treatment of ringworm, eczema, itch and other skin diseases and internally to cure boils, swelling etc. Also, reported the leaves contain the volatiles of 1-triacontanol, epifriedelinol and its acetate and B-sitosterol and these volatiles might be playing a major role as an attractant for *M. pustulata.* 1-triacontanol is known of the chemical identity of kairomone, resulted the insect uses 1- triacontanol as a kairomone to find the host *C. ternatea*, perennial climber with conspicuous blue colour flowers. The blue dye from these flowers was reported as a substitute for litmus and having lot of medicinal values for diuretic, laxative etc. Though, seeds, root-bark and leaf contain tannin (tannin = defensive compounds for the plant against insect pests, based on their accumulation), it was evident that the resistance expressed by *C. ternatea* was completely suppressed by *M. pustulata* for its effective utilization. *P. pinnata* and *A. leucophloea* are valued for tough, drought-hardy, shade, ornamental value, leaf fodder and green manure. Flowers are with violet/ pinkish colour, is the main attractant source for *M. pustulata*. Both seeds and oil of *P. pinnata* are used in indigenous systems of medicine; the oil is used for tanning, soap making and lighting purposes. The oil cake is a good fertilizer and can be used in poultry rations. In southern Rajasthan *A. leucophloea* is often the only tree left, which reflects its tolerance to adverse locality factors.

Controlling of adult beetles is very difficult because of their quick mobility. Mechanical control, hand picking or collecting in nets and destroying them is very effective in the evening time because of its aggregation behaviour as mass on flower. Soil treatment before sowing with BHC 10% or Carboforan 3G-5 to 10 gm/ plant or Chloropyriphos 20 EC of 1 litre of 0.2% emulsion/plant or Neem cake 100 gm/ plant will be helpful for controlling the adult stages of Blister beetle.

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Division of Forest Protection,
Arid Forest Research Institute,
Jodhpur (Rajasthan)

S. Murugesan,
Shivesh Kumar and
R. Sundararaj

(II)

PRELIMINARY STUDIES ON THE GERMINATION BEHAVIOUR OF SOME SHRUB SPECIES OF HIMALAYAS

Shrubs of Himalayas have attracted the attention of Foresters and other Environmentalists on account of their ability to grow on degraded sites. Maithani *et al.* (1986, 1988), have underlined the importance of shrubs in reclamation of the degraded areas and in strengthening the economy of the local people of the Himalayas. No systematic work has been reported on any of the shrub species of Himalayas for their nursery and planting technology. Silviculture Division at the Forest Research Institute has taken up the work on the seed germination and nursery techniques since 1986. The preliminary studies carried out on some of the shrub species of Himalayas for their seed germination behaviour in different soil media are reported here. Species which were taken up are (1) *Coriaria nepalensis*, (2) *Withania somnifera*, (3) *Boehmeria macrophylla*, (4) *Boehmeria platyphylla* and (5) *Hamiltonia suaveolens*.

Materials and Methods

Seeds of *Coriaria nepalensis* were collected from Mussoorie Hills in May, 1989, the seeds of *Withania somnifera* were collected from Tehri Garhwal and that of *Boehmeria macrophylla*, *Boehmeria platyphylla* and *Hamiltonia suaveolens* were also collected from Mussoorie Hills in the first week of January, 1989. The seeds were dried and extracted and sown in germination trays filled with different proportion of germination media in July 1989. Following germination media were used.

T_1 - Soil, sand and farm yard manure 2:1:1,
T_2 - Soil, sand and farm yard manure 1:1:1,
T_3 - Soil and sand 2:1,
T_4 - Soil and sand 1:1, and
T_5 - Brick soil, sand and farm yard manure 2:1:1.

In case of *Coriaria nepalensis* only 4 types of soil media was prepared. The observations on germination of seeds were recorded and mortality of seedlings were also recorded. The dead and dying seedlings were removed from the containers and the surviving seedlings were transplanted in the polythene bags.

Results and Discussion

The results of the germination obtained in different soil media is shown in Table 1. The best germination and plant percentage was noticed in *Coriaria nepalensis*. In this species highest germination was obtained in soil mixture where soil, sand and farm yard manure were in the ratio of 2:1:1 (T_1). The germination was started after 15 days and completed in 35 days. In other treatment also good germination was obtained. In other species, for example *Withania somnifera* similarly highest germination percentage was obtained by treatment T_1 (29.86) and the germination was completed after 45 days. In case of *Boehmeria*

Table 1

Species	Germination media	Commencement of germination (days)	Completion of germination (days)	Total germination (%)	Plant (%)
Coriaria nepalensis	T_1-soil:sand:F.Y.M. 2 1 1	15	30	78.54	75.00
	T_2-soil:sand:F.Y.M. 1 1 1	15	34	59.60	53.20
	T_3-soil:sand 2 1	17	35	63.20	54.40
	T_4-soil:sand 1 1	17	32	55.40	50.20
Withania somnifera	T_1-soil:sand:F.Y.M. 2 1 1	19	37	29.86	14.58
	T_2-soil:sand:F.Y.M. 1 1 1	20	41	23.88	13.19
	T_3-soil:sand 2 1	21	39	20.13	11.38
	T_4-soil:sand 1 1	21	40	14.58	6.94
	T_5-Bricksoil:sand:F.Y.M 2 1 1	21	45	9.02	2.08
Boehmeria macrophylla	T_1-soil:sand:F.Y.M. 2 1 1	13	55	6.3	3.5
	T_2-soil:sand:F.Y.M. 1 1 1	13	51	5.1	2.8
	T_3-soil:sand 2 1	14	58	41.2	31.4
	T_4-soil:sand 1 1	14	61	22.7	15.8
	T_5-Bricksoil:sand:F.Y.M. 2 1 1	18	69	4.8	2.7
Boehmeria platyphylla	T_1-soil:sand:F.Y.M. 2 1 1	6	50	20.5	16.3
	T_2-soil:sand:F.Y.M. 1 1 1	6	52	40.7	30.4
	T_3-soil:sand 2 1	7	64	45.2	33.5
	T_4-soil:sand 1 1	7	63	22.3	15.5
	T_5-Brick soil:sand:F.Y.M. 2 1 1	10	72	41.4	30.7
Hamiltonia suaveolens	T_1-Soil:snad:F.Y.M. 2 1 1	13	52	5.6	1.2
	T_2-Soil:sand:F.Y.M. 1 1 1	13	51	21.6	17.5
	T_3-Soil:sand 2 1	13	54	14.3	9.6
	T_4-Soil:sand 1 1	13	59	20.8	16.3
	T_5-Brick soil: sand:F.Y.M. 2 1 1	16	62	12.5	8.4

macrophylla the treatment T_3 where soil and sand were in the ratio of 2:1 highest germination percentage was noticed (41.2). But very poor germination was obtained in those treatments where farm yard manure was mixed. Similar results were obtained in case of *Boehmeria platyphylla* also but the germination was not so poor in other treatments. In these two species the germination continued upto 72 days. In case of *Hamiltonia suaveolens* treatment T_2 where soil and sand and farm yard manure were in the ratio of 1:1:1 gave better results.

On the basis of the preliminary studies it is felt that the germination of all theses species except *Coriaria nepalensis* and up to certain extent *Boehmeria* spp. is less and there appear to be some dormancy in the seed. Further studies are recommended on nursery and seed germination behaviour including pre-treatment studies.

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Indian Council of Forestry
Research and Education,
Dehra Dun (U.P.)

V.K. Bahuguna
and
Pyre Lal

LETTERS TO THE EDITOR
(I)

To,
The Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun. (U.P.)

Sub : **Root Trainer**

This refers to the letter of Shri A.N. Chaturvedi on root trainers published in the September, 1996 edition of your magazine.

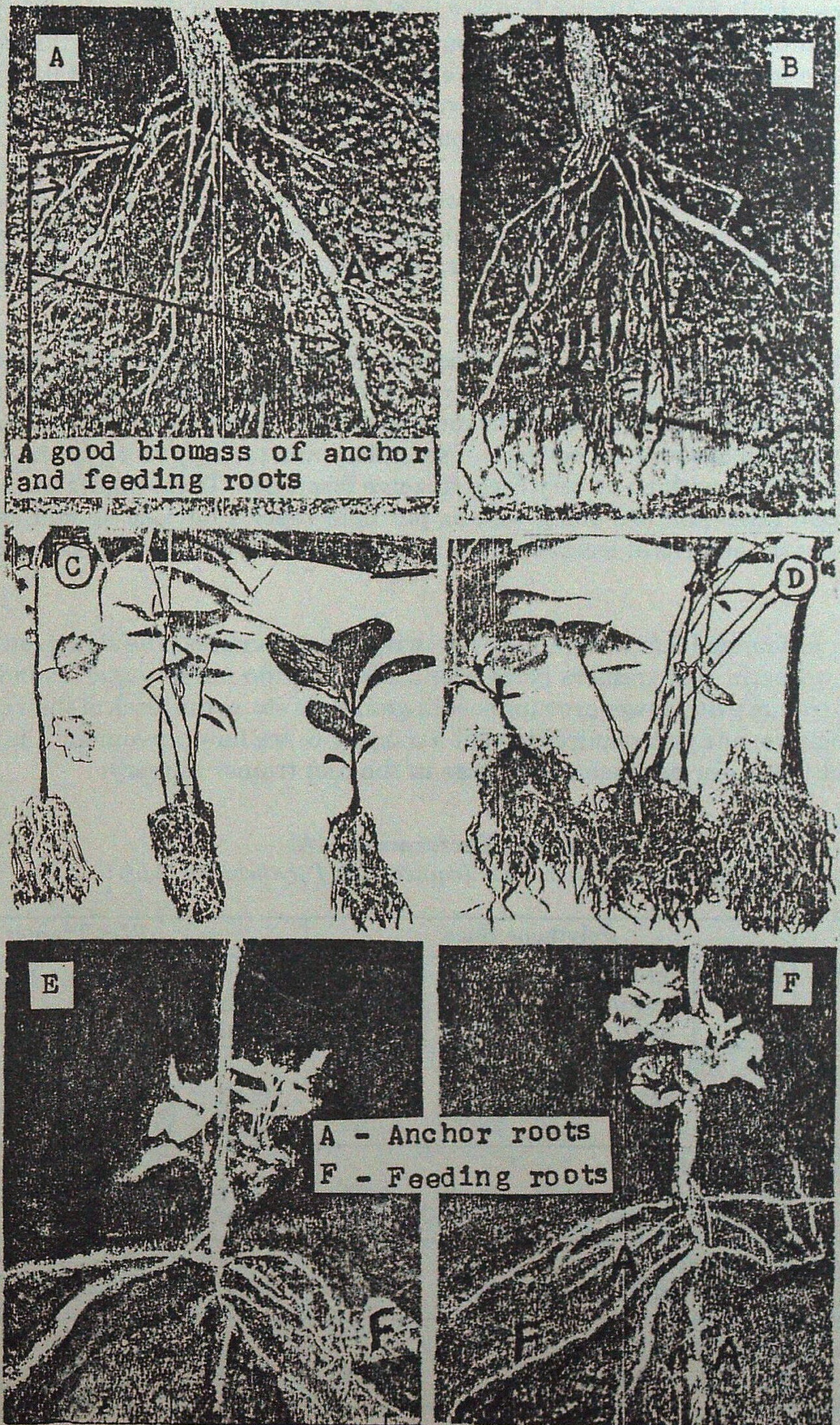
Being closely associated with the production of Root Trainer seedling stock both in 1995 and 1996 as the Regional Manager of Nashik Region and also having seen them planted in the field for more than a year or so I have found them, to be of immense practical utility, cost effective in longer run and user friendly to large extent.

With the pleasure of joining an issue with such an eminent forester, I intend to offer my parawise remarks to his criticism and would like to leave the matter to the readers to derive their own opinion about the matter :

The size of Root Trainers used was 150 cm^3, which may be small from the standard of general poly-bag size but it had a capacity to provide required succour to the plant for 90-135 days. Secondly, it was with the deliberate intention, and to cut the cost of nursery maintenance, the duration of root trainers stock in nursery was intended to not to go beyond 3-4 months. If one gets the same good stock with 3 month in nursery, then why one should keep them more and incur an excess cost of labour ? Therefore it is rather an advantage than a drawback. Thirdly, artificial fertilizers were not top dressed but were thoroughly mixed with the soil, and sand with the help of concrete mixer. Therefore, there were no turning roots upwards.

His Third point that root trainer plants do not produce tap roots when out planted. In field, when certain plants of *Gmelina arborea* were dug out, we noticed that almost in all r.t. plants instead of one tap root there were several bifurcated anchor roots going in different layers of the soil, and apart from this, a very good network of feeding roots was noticed into the root trainer raised seedlings. Polybag raised plants also had prominent anchor and feeding roots, but the biomass, the penetration and spread were definitely lesser than of root trainer seedlings. Therefore the fear that the roots of root trainer plant confine to upper soil is a misplaced one. Fig. 1 (A-F) may dispel it all together and this observation stands true for other species also. However root trainer plants raised in Makhmalabad

Fig. 1 (A-F)


A
A good biomass of anchor and feeding roots
A
F
B
C
D
E
A - Anchor roots
F - Feeding roots
F
F
A
F
A

Nursery were mainly for production forestry in high rain fall zone. Here one should admit that the versatility of root trainers in arid zone is yet to be proved, but again, the expansion of root biomass in deeper layers of soil has established the quality of adaptability of root trainer seedlings and hopefully, with improved containers and use of better clones of local arid species this problem can also be surmounted.

The fifth point of Shri Chaturvedi corroborates what was done actually. The pot mix was very evenly mixed and was so consistent that after fifteen days or so of sowing, entire ball of earth, if taken out from root trainer, would come out without any breakage and loosening of the soil.

Undesirability of root trainers for bamboos is a comment which has been given bit too early. Though, there is nothing to prove contrary also at this stage, but this year Makhmalabad nursery has produced around thirty thousand of Bamboos in root trainers, which again, as expected have given out profuse network of secondary and tertiary root system - within 3 months period, albeit with no or very little rhizome formation. These plants were planted in field in 1996 rains and are doing well as per field reports but one should keep ones comments reserved on it, as at least two more seasons should pass before their performance is evaluated.

Another unfounded fear is that, faster growing plants suppress the slow growing ones owing to crowding in root trainers block. Contrary to it, the nursery staff found it most convenient to remove the slower growing seedlings or gaps etc. to the block of their category. To see is to believe, one just requires to visit a nursery to see how convenient it is to grade and wean out the lesser promising seedlings in the root trainer nursery.

Growth Performance (A)

Comparison between Root Trainers and Polythene (in field)

	Polythene Bags					Root Trainer			
Compartments No.	Date	Net ht. Growth (cm)	SD	CV	Survival (%)	Net ht. Growth (cm)	SD	CV	Survival (%)
Gmelina arborea N = 200									
114 Amba	4.12.95	30.30	21.93	36.77	98	32.40	18.11	34.92	97.50
130 B. Pada	25.12.95	30.83	16.27	28.27	93	38.90	17.16	26.09	93.00
Acacia catechu N = 200 Polybag.									
162 B. Pada	25.11.95	27.28	30.38	34.90	98	37.11	26.70	40.97	96.50
85 Amba	4.12.95	16.80	10.90	26.75	93	27.60	12.68	26.60	96.00
Dalbergia sissoo N = 200 Poly bag									
84-A Sgams.	25.12.95	16.53	18.88	32.63	—	31.56	22.39	35.78	—
Bombax ceiba N = 200 Poly bag									
CN 173	25.11.95	16.59	—	—	92.5	21.95	11.65	27.76	95.00

Growth Performance (B)

Only Root Trainers (in field)

Compartment No.	Date of observation	Net Growth in ht. (cm)	N	$\bar{X}$ of Height	SD	CV	Survival (%)
Gmelina arborea							
130 Boripada	25.12.95	82.92	450	108.92	27.70	25.59	99
Zari	5.12.95	35.05	450	63.50	19.66	31.44	97
Dalbergia sissoo							
Bhormal 85	25.12.95	40.24	443	71.24	27.73	39.04	99
Umbar vihir CN 84 A	25.12.95	22.60	285	50.60	13.24	26.24	98
Sawardare 80 (A)	25.12.95	35.72	428	65.70	20.27	35.79	99
Acacia catechu							
142/162 Harsul	25.11.95	38.68	750	66.73	27.81	41.08	95.04
85 Amba	4.12.95	27.76	435	55.76	20.41	36.69	97.7
Bombax ceiba							
173 N. gram	25.12.95	24.76	450	44.76	8.53	18.86	85.33
152 Kohor	29.11.95	18.28	450	41.28	—	—	98.44

I do agree with Shri Chaturvedi that the blanket use of fungicide and insecticide is a bad nursery practice (theoretically), but again, for want of adequate information on disease, and species specific standard prophylactics or disease countering insecticides. The effort was to make the best of a given situation. It is a job of research people to provide the basic information on standard disease eradication programme for each and every forestry species, which unfortunately they have failed to do so and that leaves the field officers to try their own innovations, nevertheless which may be scientifically wanting at times.

His suggestion of removal of coiled root at the time of planting may be a sound suggestion academically, but when there is a massive production of seedlings in decentralized site nurseries, where the level of supervision is not very strict this exercise may lead to disastrous consequences.

His remarks, like unsuitability of root trainer seedlings for an area where there are two to three rain-less months at a stretch, are at variance with findings in the field.

Nashik in Maharashtra, and the area where these seedlings are planted gets rainfall between 1500-2500 mm but all, during four months of monsoon. So when monsoon is over there is a dry spell of atleast 8 to 9 months, and more or the less, same is true of all other western higher rainfall zones of Maharashtra. The first set of root trainers plants where planted in June 1995 and since then, have withstood the long dry spell till now and there is no reason why they will not continue to do so in future as well.

Last but not the least, one should accept with humility, that one or two years in the life of forestry species is too small a period to conclude upon the success or failure of any technology. Nonetheless signs being observed about root trainers so far, are encouraging and deserve continuity. It is left for researcher and forester to make them more universal in application for the benefit of forestry and environment.

Yours faithfully,

Sd/- A.K. Saxena
Joint Director (Plan),
Directorate of Social Forestery,
Central Building, Pune (Maharashtra)

Snippets SAWDUST

In New Zealand, millions of dollars have been lost in attempts to establish commercial shiitake mushroom farms due to contamination that affects the sensitive spores and mycelia. Forest Foods Co. has succeeded by mapping locations where the contamination factor is high, and then locating the production facility where it is low. The company uses radiata pine sawdust, which is given away by mills, in place of hardwood sawdust, which can flavour the mushrooms. Six weeks after spawning, the first flush of mushrooms appears. Carefully manipulating the environment induces several additional flushes until, at 17 weeks, the growing medium is exhausted, with all of its carbohydrates consumed. The sawdust then contains 30 percent nitrogen in the form of protein, and it can be used to feed cattle in feed lots. Cattle are not natural grain eaters and do better with high-fibre feed that is digested more slowly. They show a preference for the nitrogen enriched sawdust over grainbased feed. The enriched sawdust also has value as mulch that will not leach nitrogen from the soil, and as feed for salmon in aquiculture operations.

Source: *New Zealand Pine International, January/February 1995.*

(II)

To
The Hony. Editor,
Indian Forester,
P.O. New Forests,
Dehra Dun (U.P.)

Dear Sir,

Please refer to the article "Autonomy in the Forestry Training" written by Shri Jagdish Kishwan, DIG and Head, Research & Training Division, Ministry of Environment and Forests, Govt. of India in *The Indian Forester* Vol 122, November 1996. Asking for autonomy in the forestry training is a welcome suggession by the author but his plea to amalgamate the forestry training with the forestry research for getting more autonomy under the umbrella of the autonomous ICFRE is not at all a convincing argument.

The mandate given by the Government to IGNFA and ICFRE are quite different and distinct. In order to strengthen the forestry research the Govt. had rightly decided to create independent regional research organisations under the umbrella body of ICFRE in similar pattern of ICAR. Perhaps clubbing education with research was not a well thought out decision at that time and the name of Indian Forestry Research and Extension would have been more appropriate rather naming it Indian Forestry Research and Education. In order to justify the name, if training is clubbed with research, it will tantamount to diluting the research and may turn counterproductive.

The main reason of huge budget in the ICFRE presently is due to the free flow of bilateral and multilateral financial assistance by donor agencies to support forestry research in our country. On the contrary, the decision of accepting ODA assistance for the development of IGNFA as well as the forestry training in the central sector remained unfortunate as ODA's hidden agenda behind it was only to support UK based universities for selling their training programmes designed for the trainers rather to make real investment in India for the infrastructural development of training in the forestry sector

In fact, the IGNFA is the premier institute of forestry training where in-service training is imparted to the new entrants of the Indian Forest Service. Thus it is alma-mater of all those who are responsible to decide policy and direction either at the level of ICFRE or in the Paryavaran Bhawan at New Delhi. My humble contention is if our officers sitting in the Paryavaran Bhawan did not remain sensitive to the problems of their alma-mater what is the guarantee that our fellow officers of ICFRE will not maintain similiar view towards IGNFA if the proposed merger as envisaged by the author once comes through.

IGNFA today is facing an identity crisis in all respects and being suppressed by a large organisation with its imposing building. It can only develop if it moves to its separate campus even with a limited autonomy. We have a model as in case of Wildlife Institute of India which has already made its niche in such a short time after it moved out of the New Forest campus. The author could have certainly done something from the position he occupied in the Ministry for his alma-mater. Such opportunties do not come time and again. Now there is no need to cry over spilt milk and suggest something which will cause more damage than good.

Yours faithfully,

Sd/- Abhijit Ghose,
Conservator of Forests,
Van Bhawan, Jaipur (Rajasthan)

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(III)

To,
The Hony. Editor,
Indian Forester,
P.O. New Forest,
Dehra Dun (U.P.)

Sub : **Gregarious flowing of *Babmusa nutans* in Nepal Himalaya**

Sir,

Please find herewith a note on flowering of bamboo in Nepal Himalaya observed by me during the summer of 1996. Kindly publish this note in your esteemed journal for the benefit of readers and bamboo researchers.

Bambusa nutans Wall. ex Munro is one of the most important and common bamboos of Nepal. It is used by the local inhabitants for variety of purposes and commonly planted near villages. This clump forming bamboo attains 15-17 m height. The bamboo is easily distinguished by its culm-sheaths which measure 15-25 cm in length and 25-35 cm in width and are with scattered black hairs on the back. Flowers are characteristically arranged on spicate branches with clusters of erect spikelets in bracteate heads. Bamboo is reported to flower at long intervals as evidently recorded by Biswas and Bhuyan (*Indian Forester*, 122 (3) : 275. 1996) from Northeastern region of India. Gregarious flowering of the species as per the herbarium record is after a lapse of 35 years in adjoining Indian region of its distribution. Author of this note observed this species flowering gregariously in the vicinity of Pokhara and Kathmandu in the month of May, 1996. The degenerated clumps found in the area of observation indicate that the flowering cycle seemed to have begun during later part of the year 1995. There is no record of report on the gregarious flowering of *Bambusa nutans* from Nepal Himalayas. However, Biswas and Bhuyan reported the flowering of this species from vicinity of Dehra Dun and Nagaon Division of Assam during the summer of May, 1995 corresponding to 14-15 years of flowering cycle. Since this bamboo is of rural-economic importance for its variety of uses a systematic survey on the gregariously and sporadically flowering clumps in Nepal and adjoining Himalaya is needed for the collection of seeds for plantation purposes.

A voucher Herbarium specimen of flowering material of the bamboo has been deposited in Herbarium of Forest Research Institute (DD) Dehra Dun for record.

Yours faithfully,
Sd/- Sas. Biswas
Sytematic Botany Discipline,
Division of Botany,
Forest Research Institute,
Dehra Dun (U.P.)

REVIEWS

(I)

Vetiver Grass for Soil and Water Conservation, Land Rehabilitation, and Embankment Stabilization. Ed. by Richard G. Grimshow and Larisa Helfer. Published by the World Bank, Washington and distributed by M/s. Allied Publishers Ltd., Madras and their branches all over India. 281 pages, many figures and plates. Price $ 16.95.

This publication is a collection of papers and Newsletters compiled by the Vetiver network in the result of seven years of research and development carried out on Vetiver grass. The publication includes ten newsletters and four papers on Vetiver grass on soil and water conservation, land rehabilitation (degraded and land mines etc.), embankment stabilization, usefulness and applicability. This publication will be useful to foresters, researchers, scientists, farmers and those interested.

- N.S.B.

(II)

Agroforestry for Sustained Productivity in Arid Regions. Ed. by J.P. Gupta and B.M. Sharma. Published by M/s. Scientific Publishers, Jodhpur. 210 pages, 8 figures, 5 B/W plates and 4 colour plates. Price Rs. 550/-

This book is the outcome of valuable information obtained by the Central Arid Zone Research Institute (CAZRI), Jodhpur on the development of different agroforestry systems for different land types and agro-ecological sub-regions. The book, in its 23 chapters, is a compilation on various aspects of agroforestry like soil, climate, nutrient, water, improved genotypes of trees and grasses, insect pest management, socio-economic settings and transfer of technology for sustainability to arid regions. This book will be valuable to researchers, extension workers and all others engaged in development of the arid regions.

- S.K.A.

FELICITATION

Dr. S.K. Benerjee, Scientist-SF, Tropical Forest Research Institute, Jabalpur has been awarded the "Vishishth Vaigyanik Puraskar" for the year 1994-95 by the Ministry of Environment and Forests, Govt. of India, New Delhi for his outstanding work in the field of eco-regeneration.

GAZETTE NOTIFICATIONS

ANDHRA PRADESH

Shri N. Linganna, IFS has taken over charge of the post of Chief Conservator of Forests (Vig.), O/o the Prl. Chief Conservator of Forests, A.P., Hyderabad from Shri T. Ramakrishna, IFS, Chief Conservator of Forests, on the AN of 31-3-1997.

Shri T. Ramakrishna, IFS has taken over charge of the post of Chief Conservator of Forests (Dev.), O/o the Prl. Chief Conservator of Forests, A.P. Hyderabad from Shri M. Sultan Mohiuddin, IFS, Chief Conservator of Forests on the AN of 31-3-1997.

Shri M. Sultan Mohiuddin, IFS has taken over charge of the post of Chief Conservator of Forests (Adm.), O/o the Prl. Chief Conservator of Forests, A.P. Hyderabad from Shri C. Subba Rao, IFS, Chief Conservator of Forests on the AN of 31-3-1997.

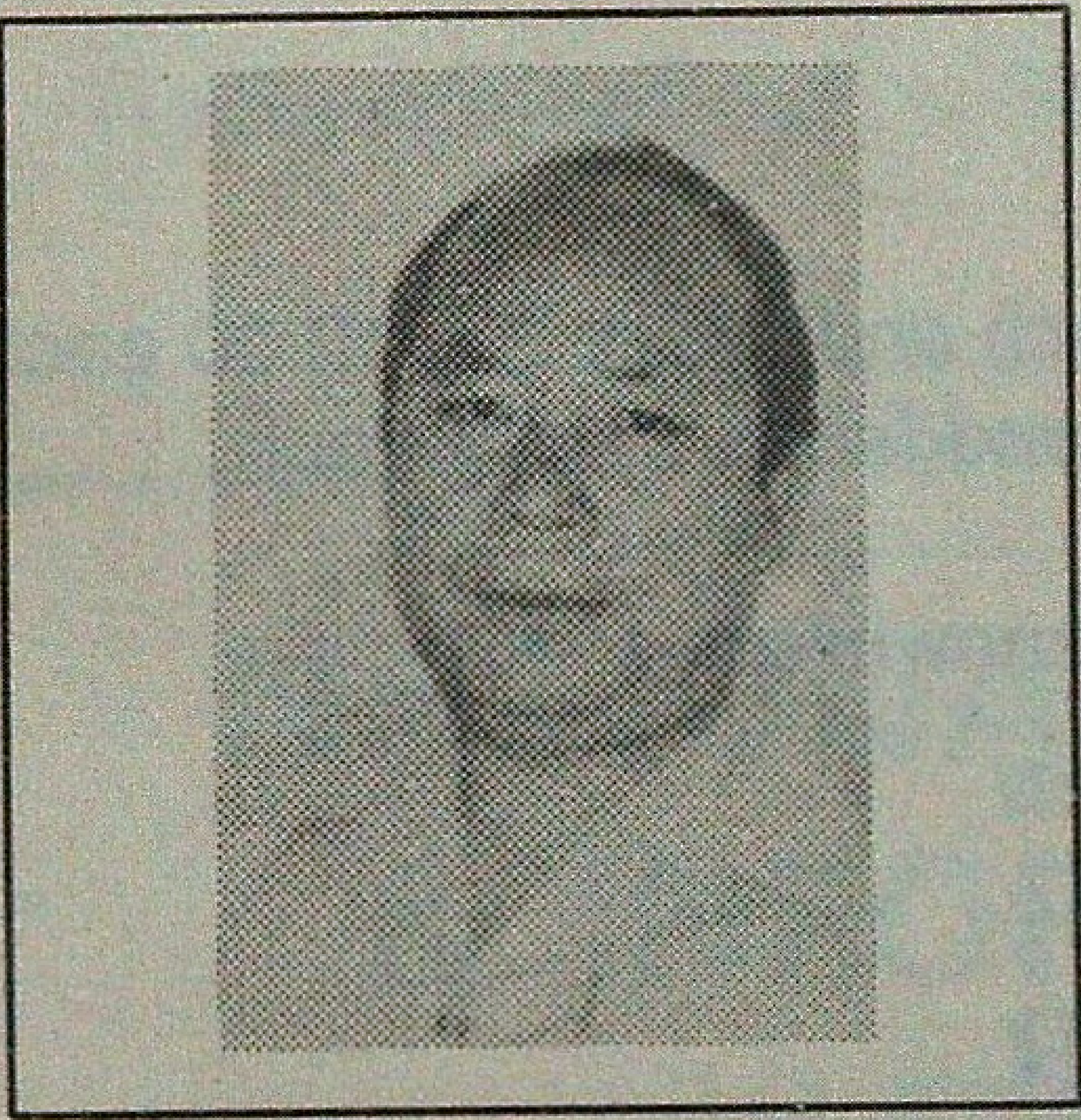
Shri C. Subba Rao, IFS has taken over charge of the post of Chief Conservator of Forests (Prod.), O/o the Prl. Chief Conservator of Forests, A.P. Hyderabad from Shri N. Linganna, IFS, Chief Conservator of Forests on the AN of 31-3-1997.

Shri P.A.V. Udayabhaskar, IFS (85) Divisional Forest Officer, Nadyal is transferred and his services are placed at the disposal of Panchayat Raj and Rural Development Deptt. for appointment as Project Director, Drought Prone Area Programme, Mahboobnagar on deputation basis.

OBITUARY

N. Kunja Singh

(1-2-1933 - 1-5-1990)



Shri N. Kunja Singh, I.F.S., Additional Chief Conservator of Forests -II (Planning and Development), Manipur, passed away on 1-5-1990 at Imphal. He was a very dedicated forester. The Government of India nominated him member from the Eastern Region to review the Indian Forest Act. He is survived by his wife and four sons and a huge number of friends, colleagues and admirers.

May his soul rest in peace and Almighty give sufficient strength to all to bear his irreparable loss.

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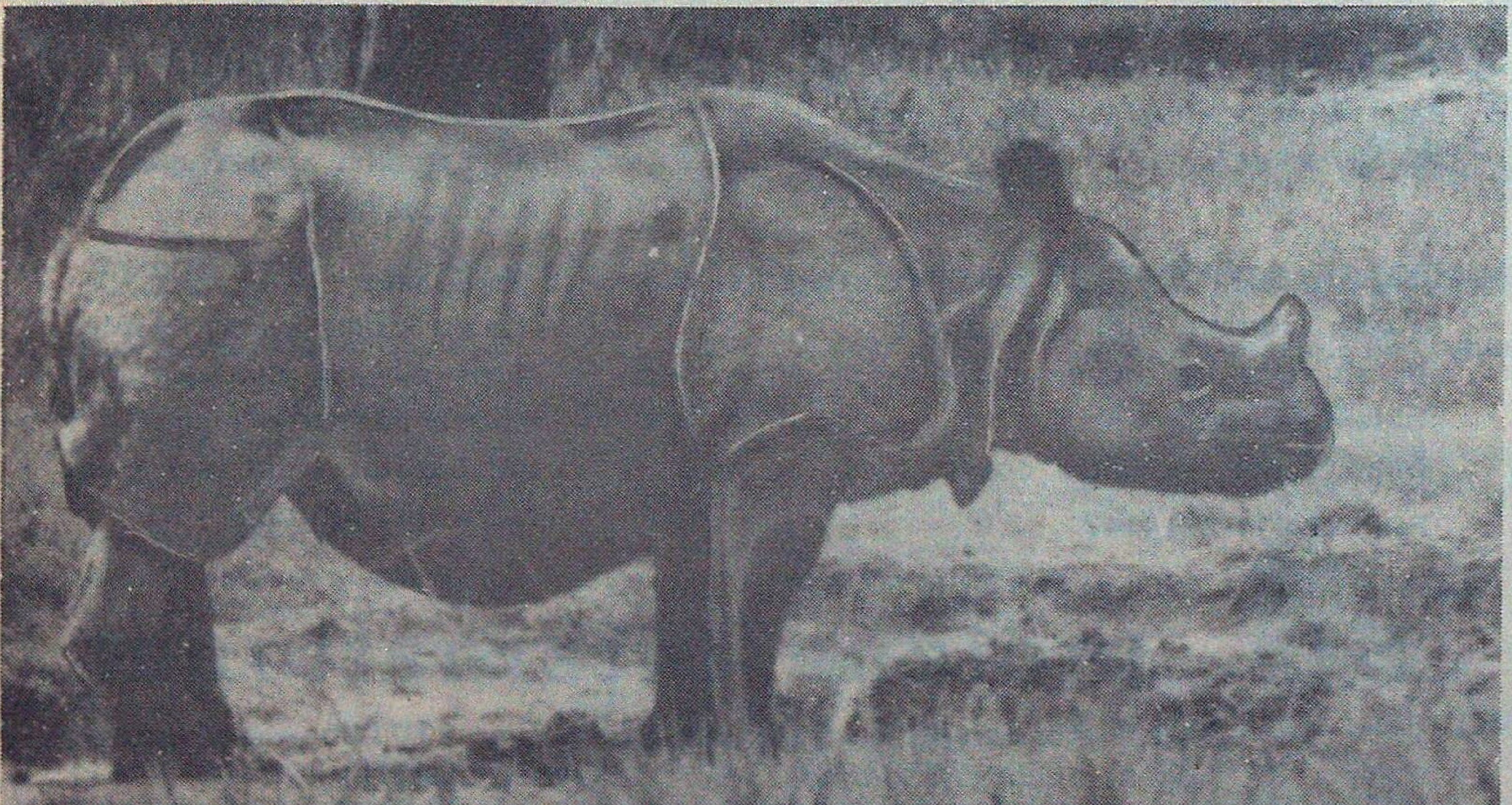

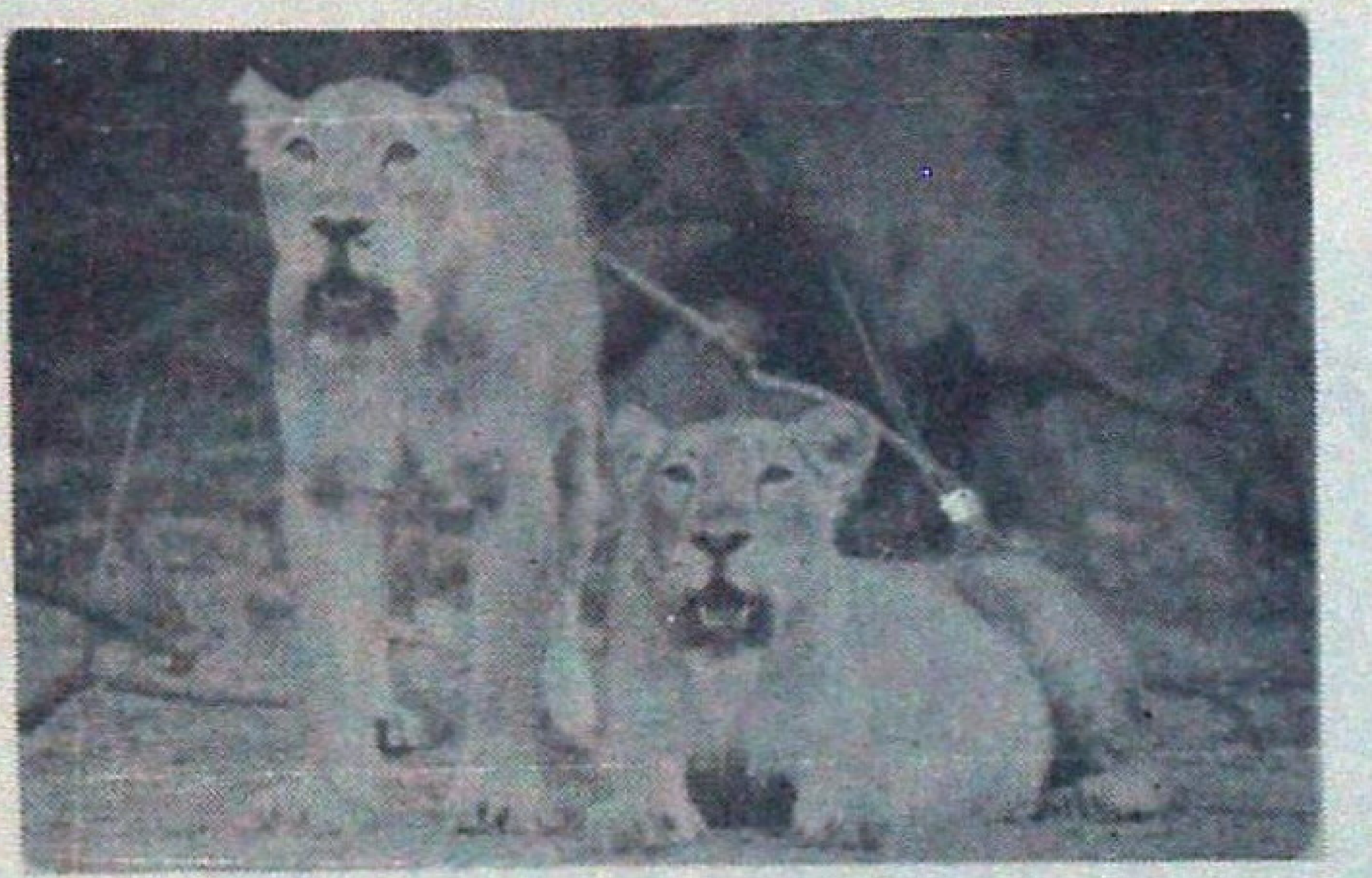

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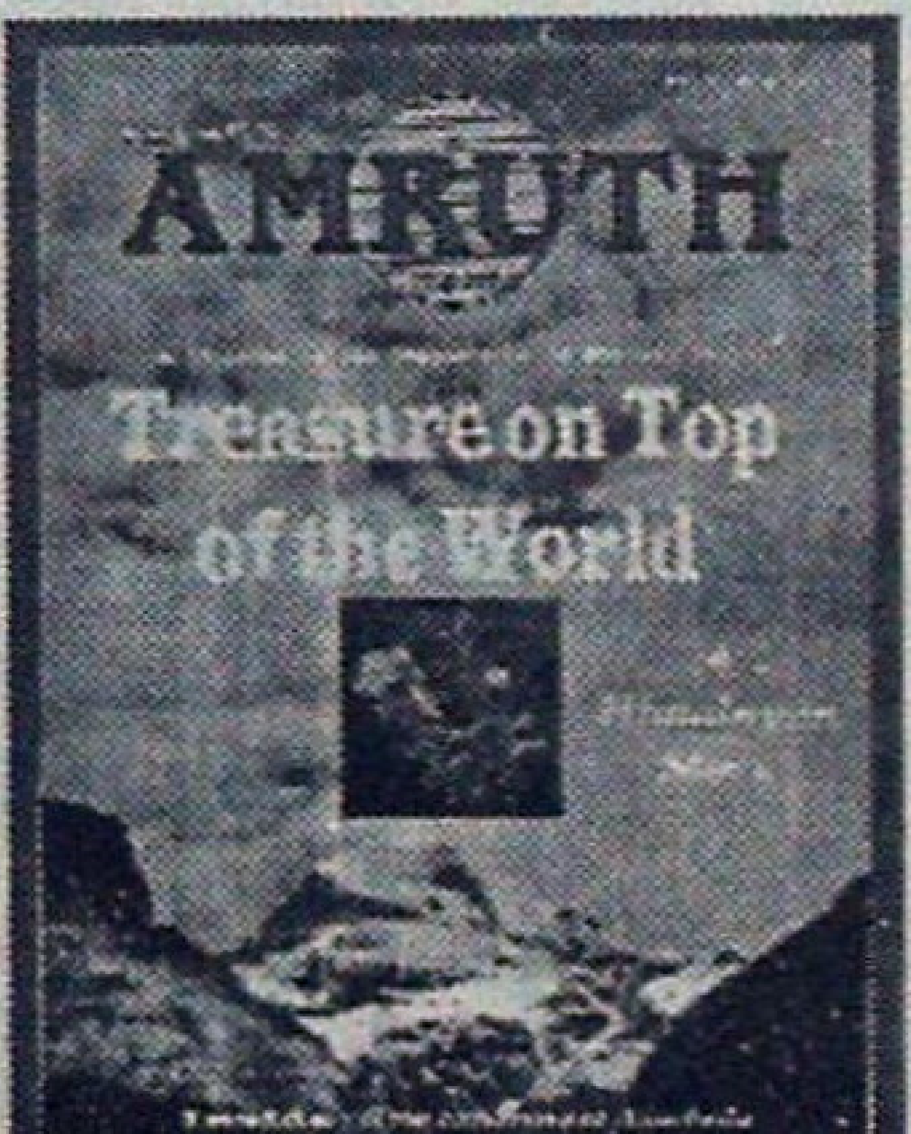

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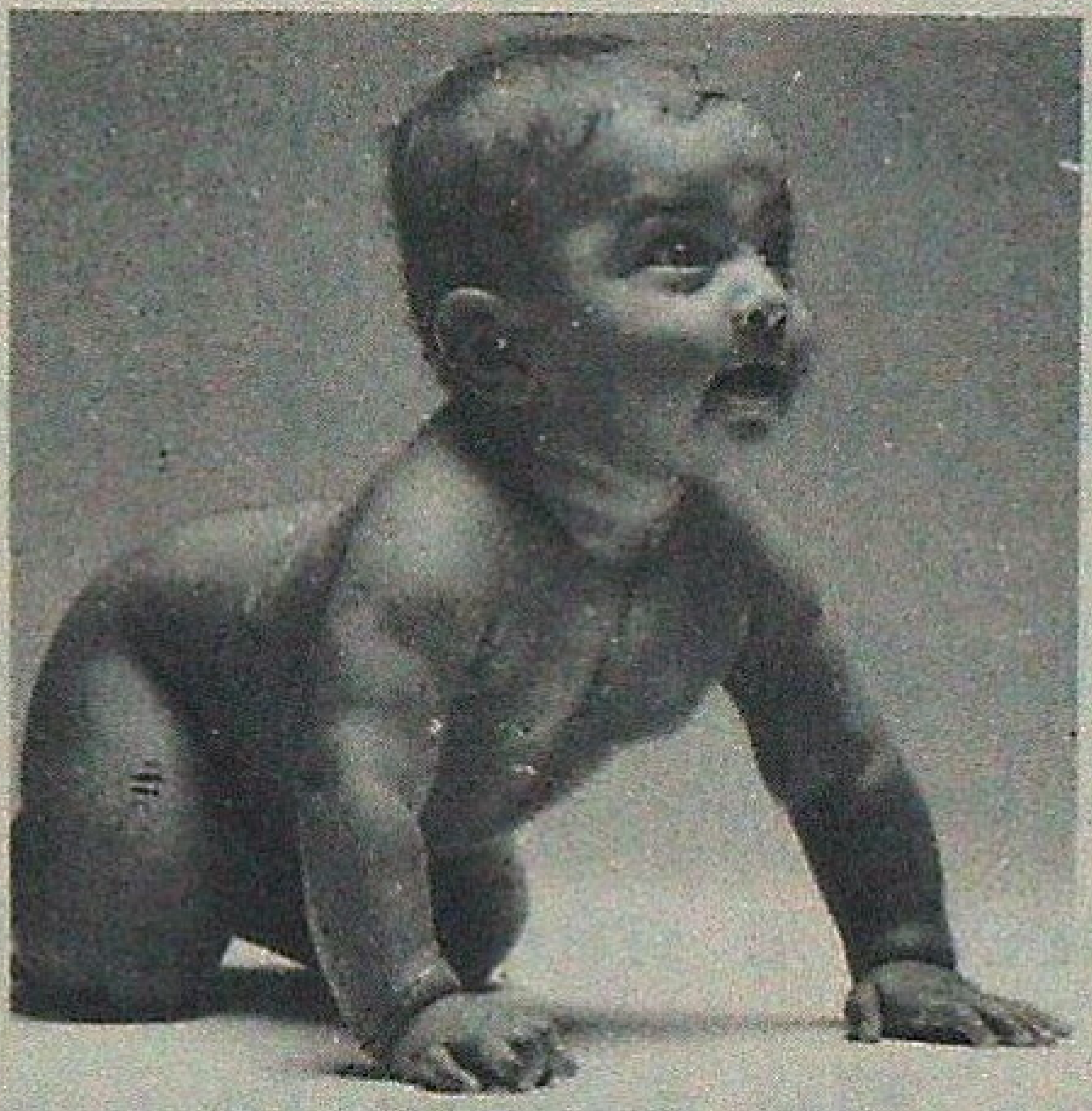

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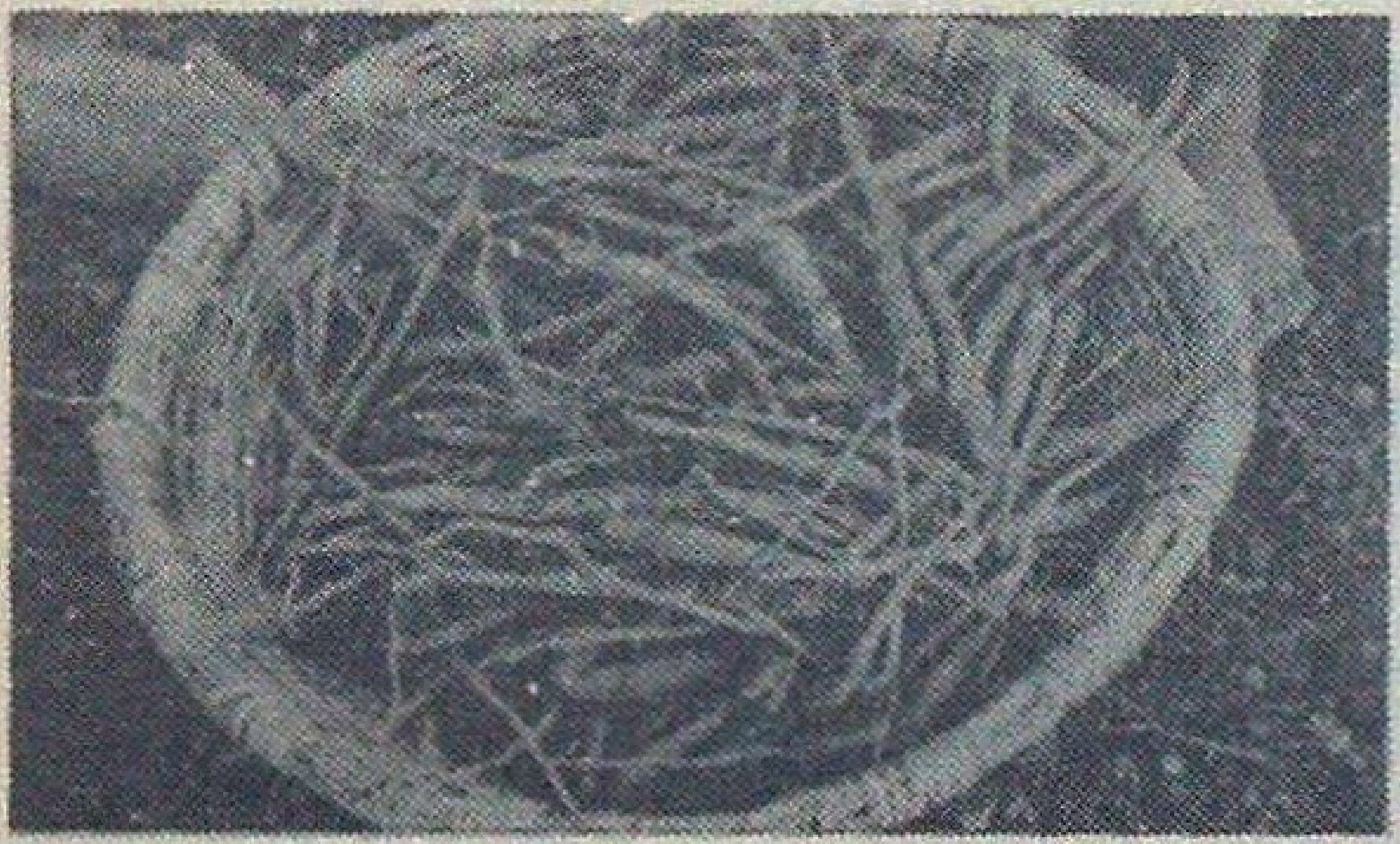

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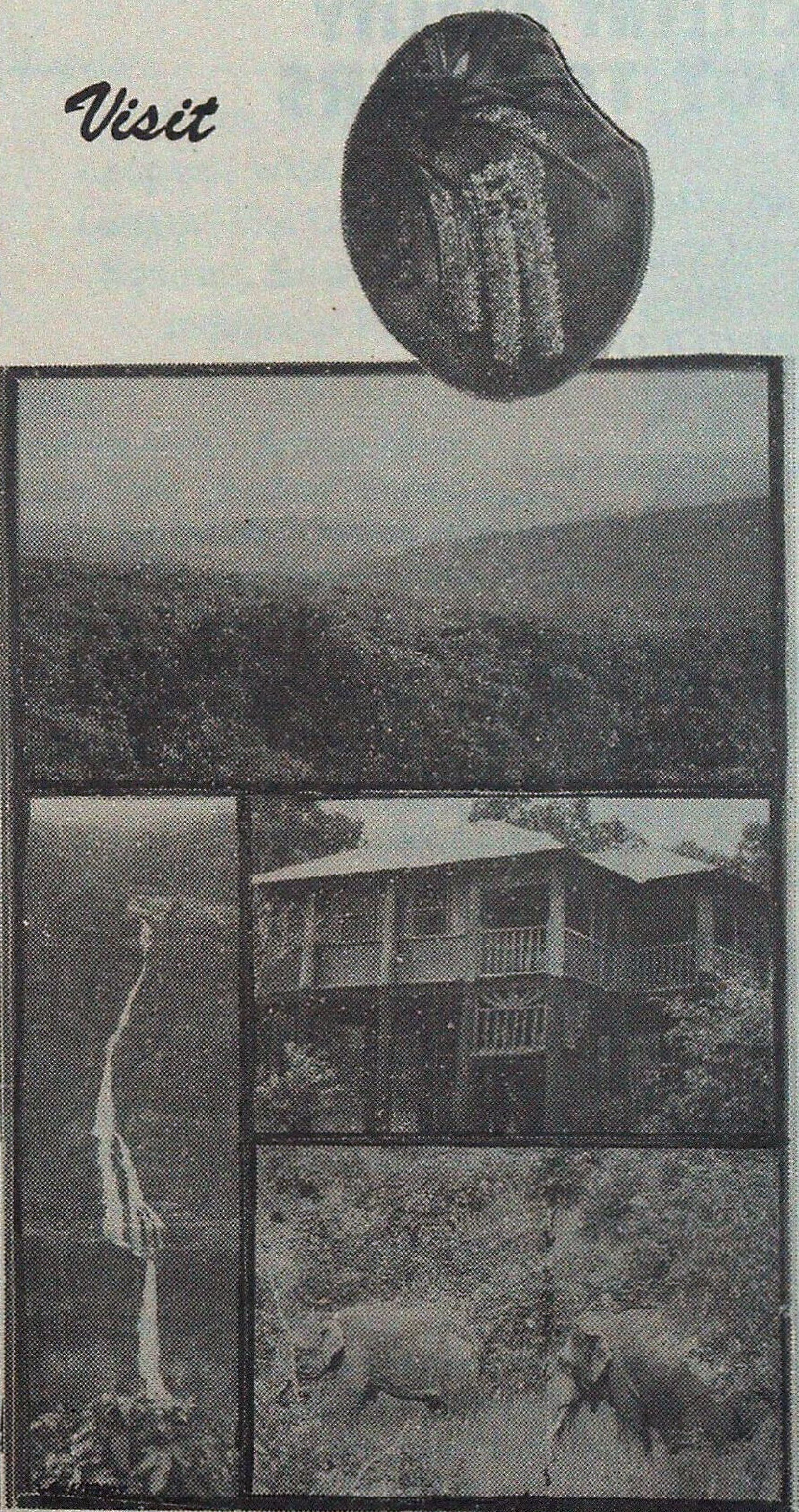

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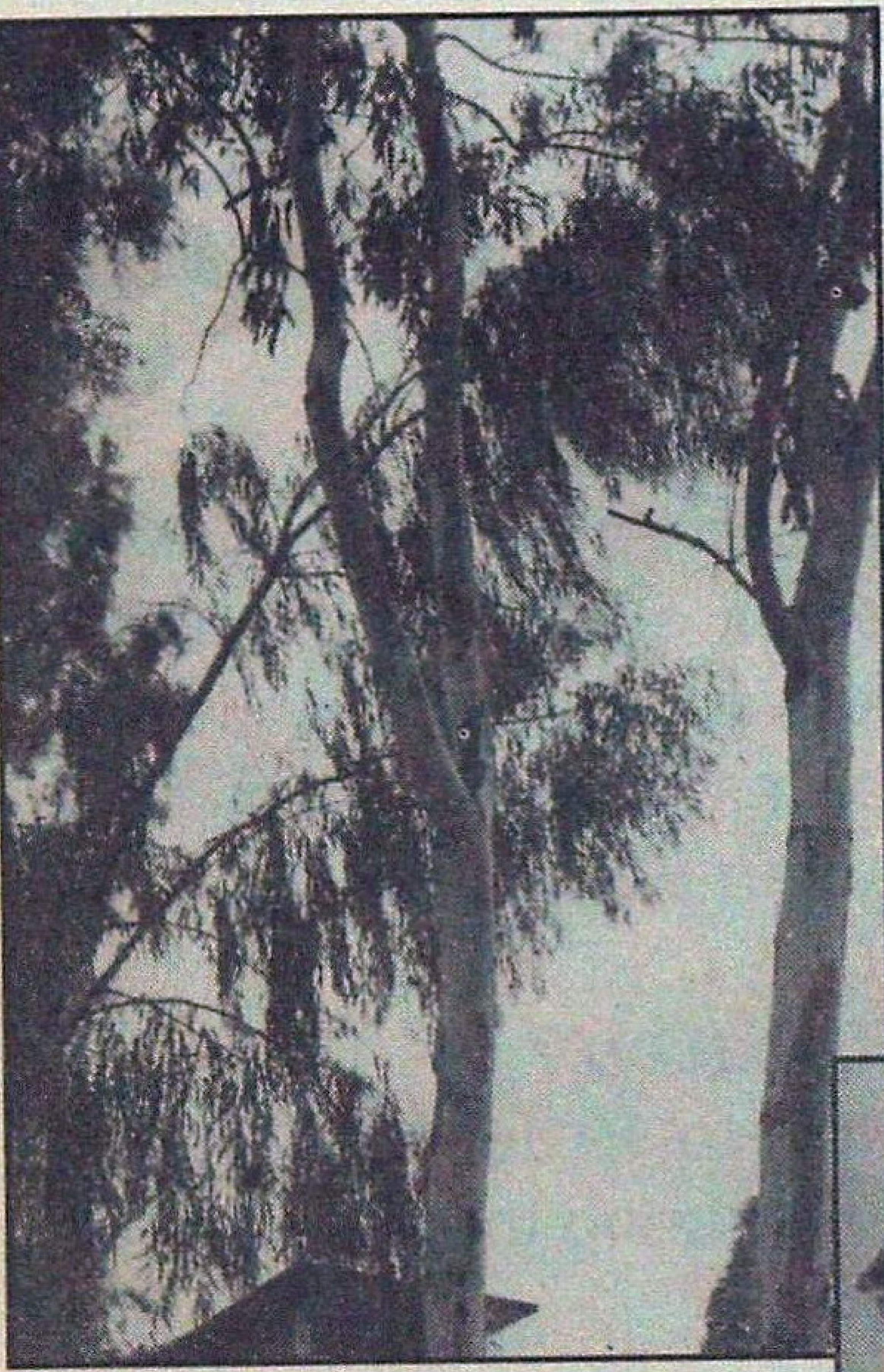

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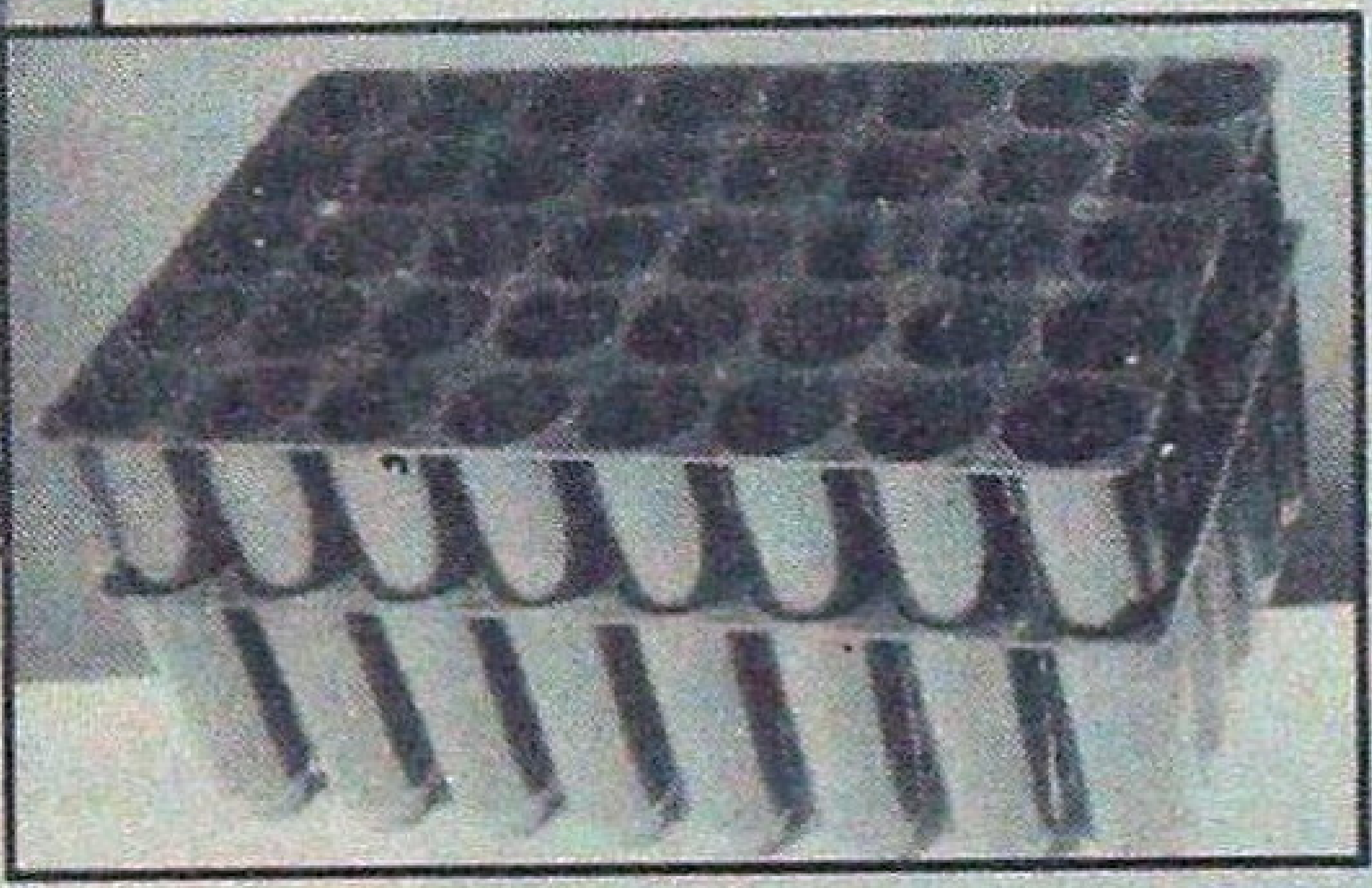

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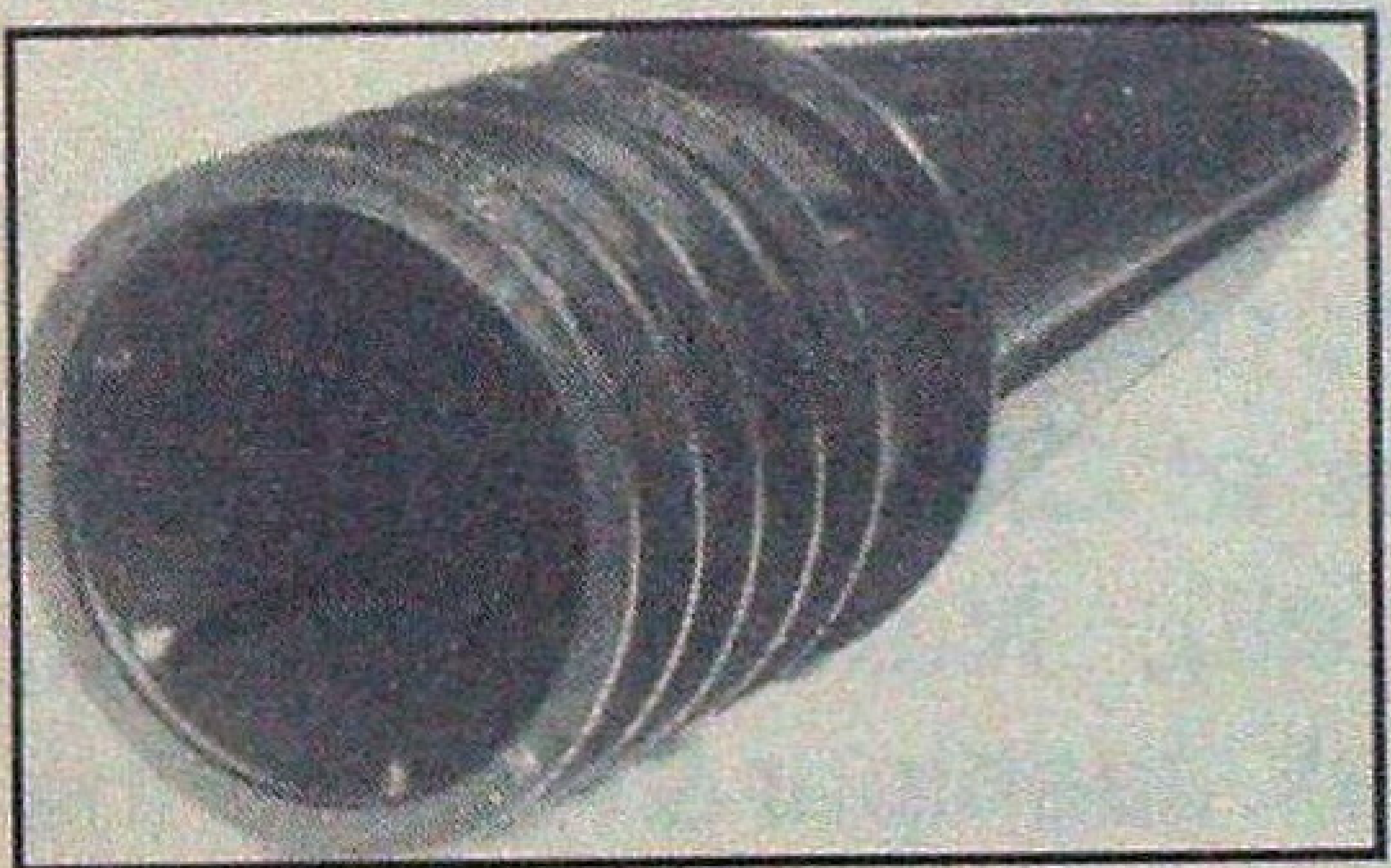

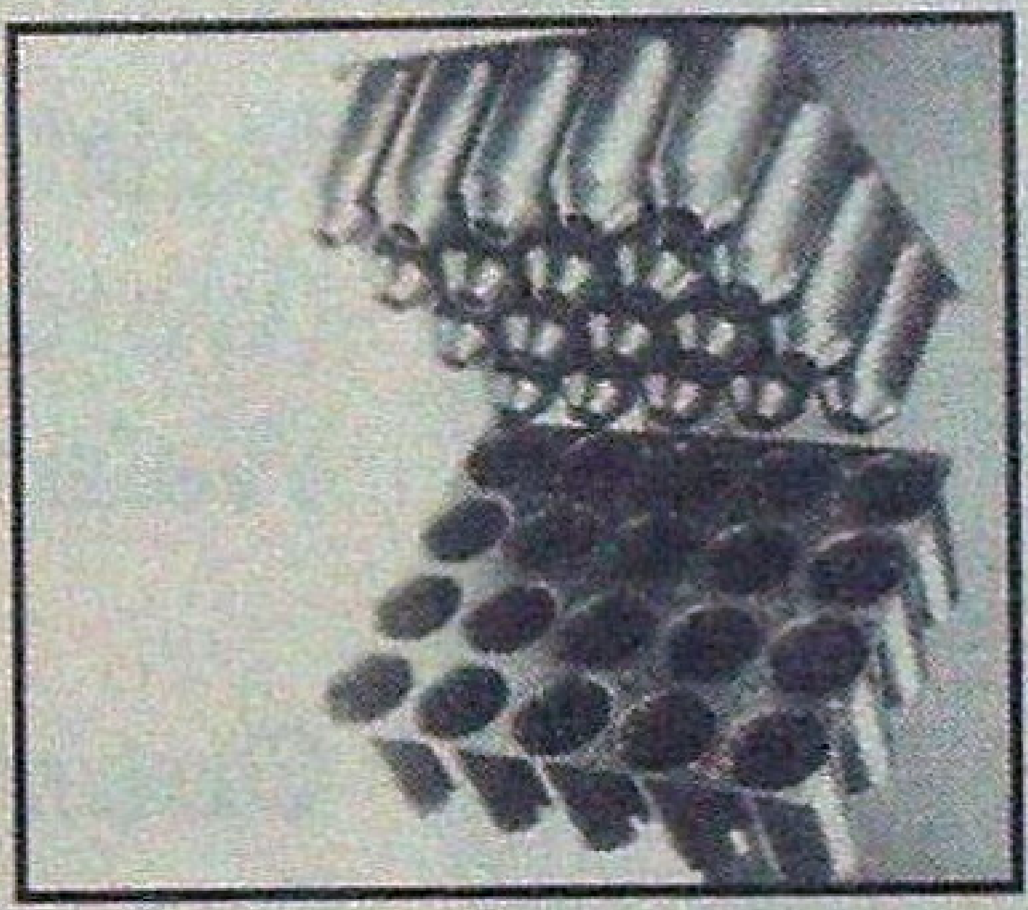

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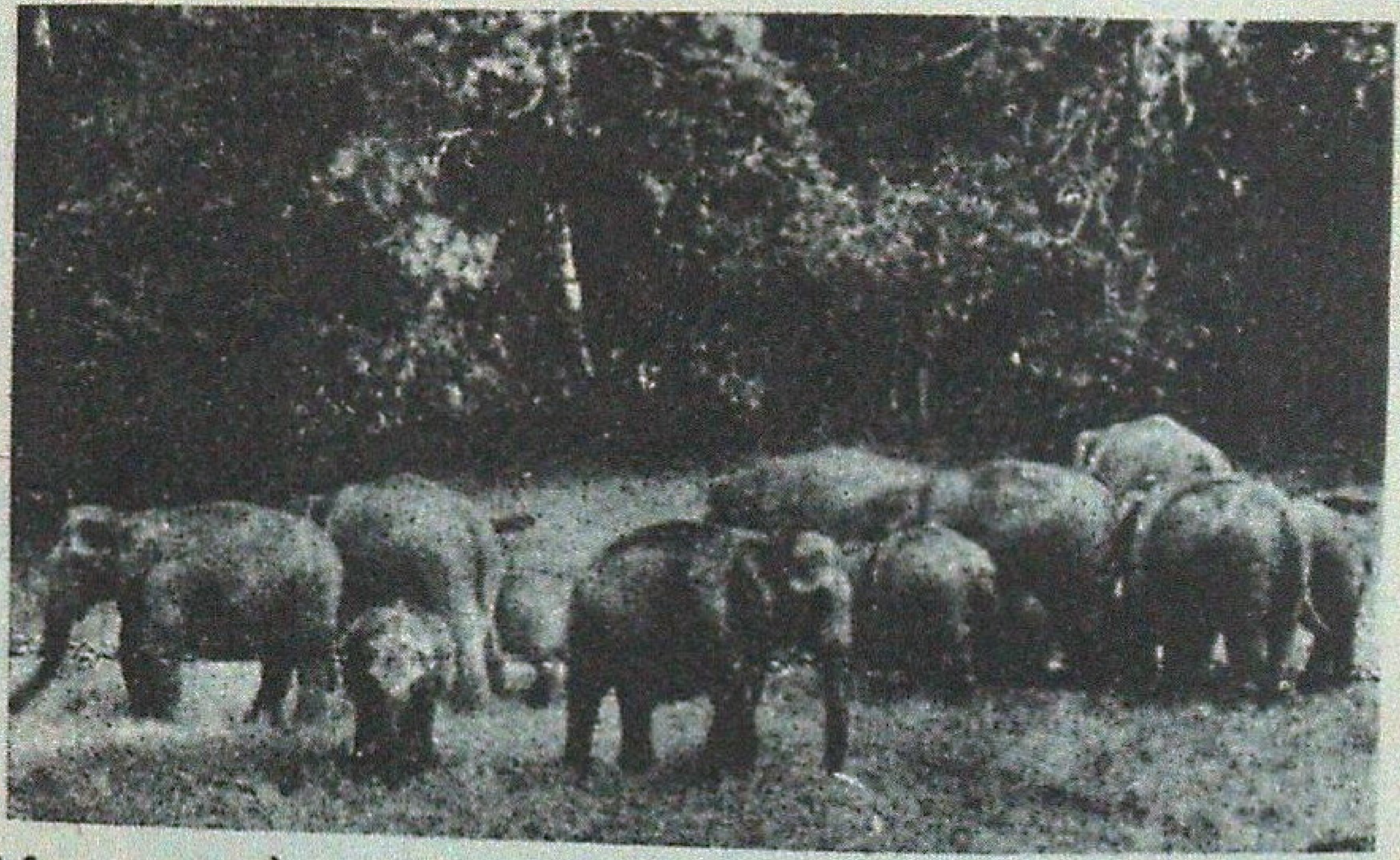

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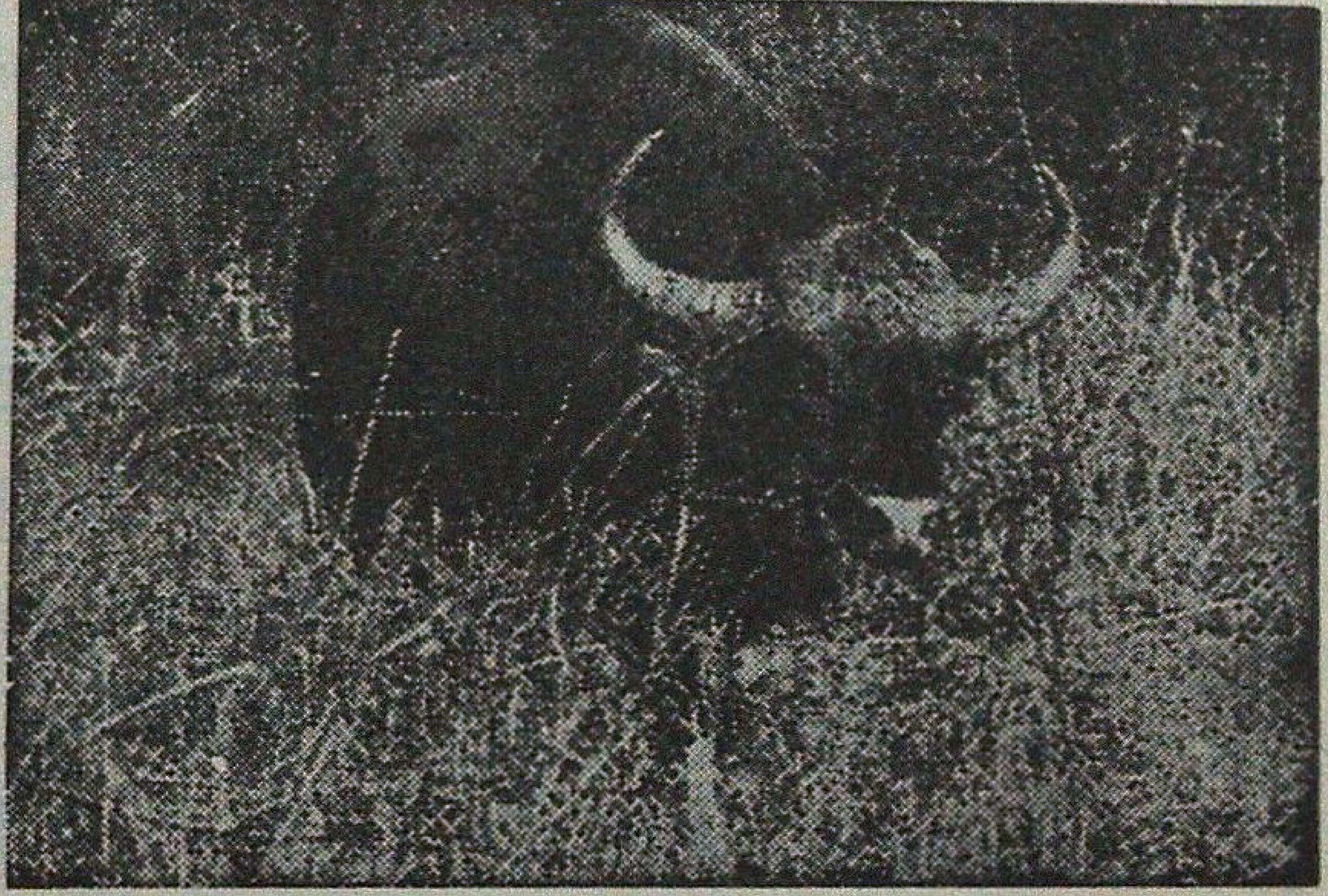

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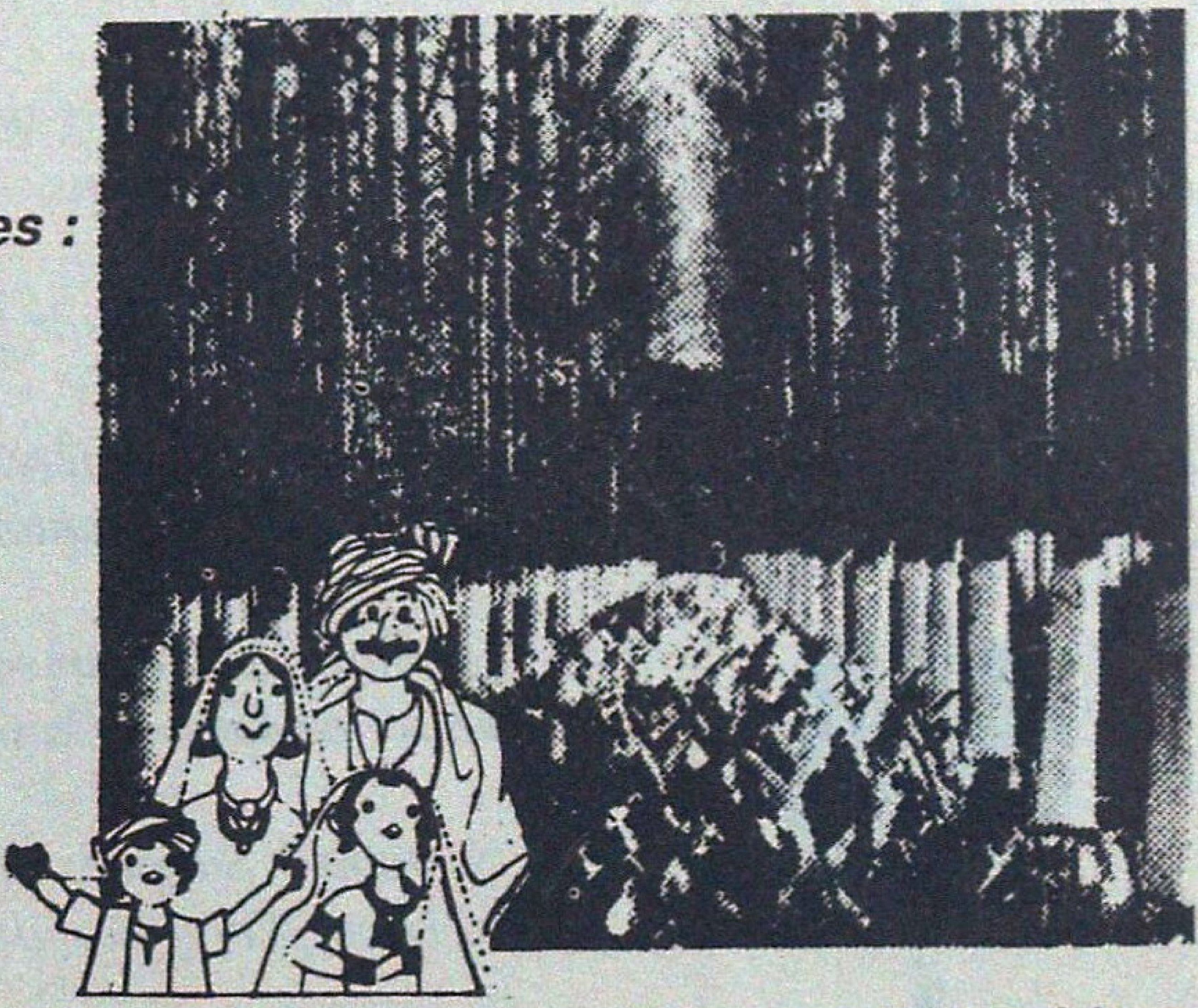

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About 10,000 persons eke out their livelihood directly, and about the same number indirectly, from forests.

* Settlers and agriculturists enjoy many rights and concessions on forest produce to build their dwellings and to go about their occupation.

* Fascinating wildlife like Megapode, Narcondum Hornbill, Crab Eating Maçaque, Robber Crab, Swiftlet, feral goats, feral buffaloes and neo-feral elephants are exclusive possessions of these islands - not forgetting the longest centipede (*Scolopendra andamanensis*), measuring over a foot.

* Through scientific management of a small part of the islands, forests contribute upto 50% of the total revenue of the territory.

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Biological diversity is important for maintaining the long term health and productivity of natural forests.

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